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## A New Species of *Phymatocarpus* (Myrtaceae) from Southwestern Australia

L.A. Craven

Australian National Herbarium, Centre for Plant Biodiversity Research, CSIRO Plant Industry, GPO Box 1600, Canberra, ACT 2601, Australia.

### Abstract

*Phymatocarpus interioris* Craven is described newly. A key to the three species of *Phymatocarpus* is provided and their distributions are mapped.

### Introduction

The Western Australian genus *Phymatocarpus* F. Muell. was established in 1862 with *P. porphyrocephalus* F. Muell. its sole, and hence type, species. Mueller added a second species, *P. maxwellii* F. Muell. in 1875. Both of these species have a more or less coastal distribution, the former in the Murchison River-Eneabba region and the latter from Mount Barker east to Israelite Bay. During preparation of an account of the genus for *Flora of Australia* it was noted that several populations, seemingly of *P. maxwellii*, occurred in the Lake King-Peak Charles area to the north of the range of *P. maxwellii*. Further investigation showed that these populations represent an undescribed species of the genus; this is described below as *P. interioris*.

### Taxonomy

1. *Phymatocarpus porphyrocephalus* F. Muell., *Fragm.* 3: 121 (1862). *Typus*: Western Australia, sand plain S of Murchison River, *Oldfield* s.n. (holotypus MEL 1059023).

2. *Phymatocarpus maxwellii* F. Muell., *Fragm.* 9: 45 (1875), as *maxwellii*. *Typus*: Western Australia, near Cape Arid, 1875, *Maxwell* s.n. (holotypus MEL 1059015).

*Regelia sparsifolia* W. Fitzg., *J. Bot.* 50: 21 (1912). *Typus*: Western Australia, Esperance Bay, Oct. 1903, *Daw* s.n. (holotypus NSW; isotypus MEL fragm.).

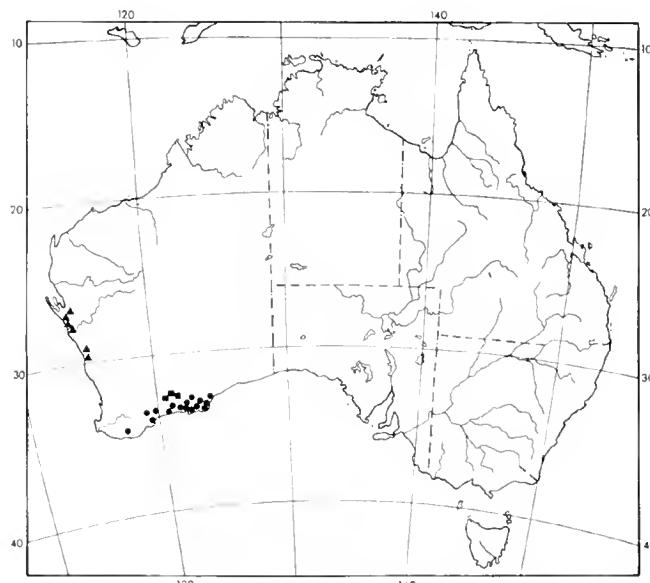
3. *Phymatocarpus interioris* Craven, *sp. nov.*

A *P. maxwellii* F. Muell. staminibus non distincte fasciculatis et annulo staminali et a *P. porphyrocephalo* F. Muell. staminibus paucioribus (23–30), floribus ebracteolatis et lamina foliorum venis numerosioribus (5–9) differt.

*Typus*: Western Australia, c. 65 km W of Daniell, 15 Sep 1964, *Kuchel* 1798 (holotypus AD; isotypus CANB).

*Shrub* to 1.5 m tall. *Leaves* 4.4–9.2 mm long, 3–7.5 mm wide, short-petiolate or subsessile; blade glabrous or hairy, very broadly ovate to circular to transversely broadly elliptic, in transverse section sublunate, the veins 5–9 and parallel-pinnate. *Inflorescence* with 2–6 triads; bracteoles absent. *Hypanthium* sericeous. *Sepals* costate or not, very broadly triangular or elliptic, 0.7–0.8 mm long. *Staminal ring* well developed, 1.4–2.8 mm long. *Stamens* 23–30 per flower, often in distinct antepetalous clusters (the bundle claw *per se* weakly developed), the filaments glabrous, mauve, purple or pink, 3.3–5.5 mm long. *Style* 7–8 mm long. *Ovules* 5–10 per locule. *Fruit* 2.7–3.9 mm long with the distal rim flat or more or less so. *Seed* generally obovoid; cotyledons obvolute.

*Selected specimens examined* (c. 12 seen): WESTERN AUSTRALIA: 93.2 km from Lake King Post Office along the Norseman road, 5 Nov 1994, Craven, Lepisci & Holliday 9599 (A, ASU, CANB,



**Fig. 1.** Distributions of the species of *Phymatocarpus*. ■ *P. interioris* ● *P. maxwellii*  
▲ *P. porphyrocephalus*

E. L. MEL, NSW, P, PERTH); 2.6 km N of Peak Eleanora, 3.8 km E of Fields Road on Peak Charles Road, 2 Oct 1983, Burgman & McNee 2605 (PERTH); 22 km W of 90-Mile Tank on the Daniell-Lake King road, 10 Oct 1973, Demarz 4649 (PERTH); 54 km W of Kunarl which is c. 122 km N of Esperance, 10 Oct 1966, Wilson 5697 (PERTH).

*Notes:* *Phymatocarpus interioris* occurs in southern Western Australia in the Lake King-Peak Charles area (Fig. 1). It grows in mallee and eucalypt woodland, shrubland and low heathland, apparently preferring well-drained sandy soil that often overlies clay. Flowers have been recorded between September and November.

Specimens that are assigned now to *P. interioris* previously were often identified as *P. maxwellii*, perhaps because of the similar leaf colour and, for the narrower-leaved plants, similar leaf blade shape. The well developed staminal ring, however, clearly distinguishes *P. interioris* from *P. maxwellii* and is a feature possessed in common with *P. porphyrocephalus* from which it differs as given in the key below.

#### Key to the species of *Phymatocarpus*

1. Stamens distinctly 5-bundled, staminal ring absent.....*P. maxwellii*
1. Stamens not distinctly 5-bundled (although often aggregated into clusters opposite the petals and then with weakly developed bundle claws), staminal ring well-developed (1.4–3 mm long).
  2. Stamens 46–71 per flower; flowers bracteolate; leaf blade broadly elliptic, elliptic, obovate, angular-obovate or subcircular, the venation parallel-pinnate with 1–3 veins .....*P. porphyrocephalus*
  2. Stamens 23–30 per flower; flowers ebracteolate; leaf blade very broadly ovate, broadly ovate, circular or transversely broadly elliptic, the venation parallel-pinnate with 5–9 veins .....*P. interioris*

#### Acknowledgments

The directors and curators of the following herbaria are thanked for the opportunity to study collections in their care: AD, CANB, MEL, NSW, PERTH. Julie Mataczyk is thanked for her assistance with bibliographic work and data collection. Preparation of this paper in part was supported by the Australian Biological Resources Study.

## Studies on the lichen genus *Cladina* Nyl. in Tasmania: the *C. aggregata* Complex

Gintaras Kantvilas<sup>1</sup> and John A. Elix<sup>2</sup>

<sup>1</sup>Tasmanian Herbarium, G.P.O. Box 252-04, Hobart, Tasmania, Australia 7001.

<sup>2</sup>Department of Chemistry, The Faculties, Australian National University, Canberra, A.C.T., Australia 0200.

### Abstract

The *Cladina aggregata* complex represents one of the most chemically and morphologically variable groups of lichens in southern Australasia, especially Tasmania. The complex is reviewed and eight species are recognised: the widespread *C. aggregata* (Sw.) Nyl., *C. inflata* (F. Wilson) D.J. Galloway and *C. schizophora* (Nyl.) Nyl.; and five species endemic to Tasmania: *C. deformis* Kantvilas & Elix sp. nov., *C. dumicola* Kantvilas & Elix sp. nov., *C. moniliformis* Kantvilas & Elix, *C. mutabilis* Kantvilas & Elix sp. nov. and *C. oreophila* Kantvilas & Elix sp. nov. The species are all characterised by a combination of habit, gross morphology, size of ascospores and conidia, and medullary chemistry. Within *C. aggregata* itself, six chemical races are identified: barbatic acid, fumarprotocetraric acid, stictic acid, psoromic acid, diffractaic acid and norstictic acid; the last two are not known to occur in Tasmanian species. A revised key to all thirteen species of *Cladina* Nyl. is provided.

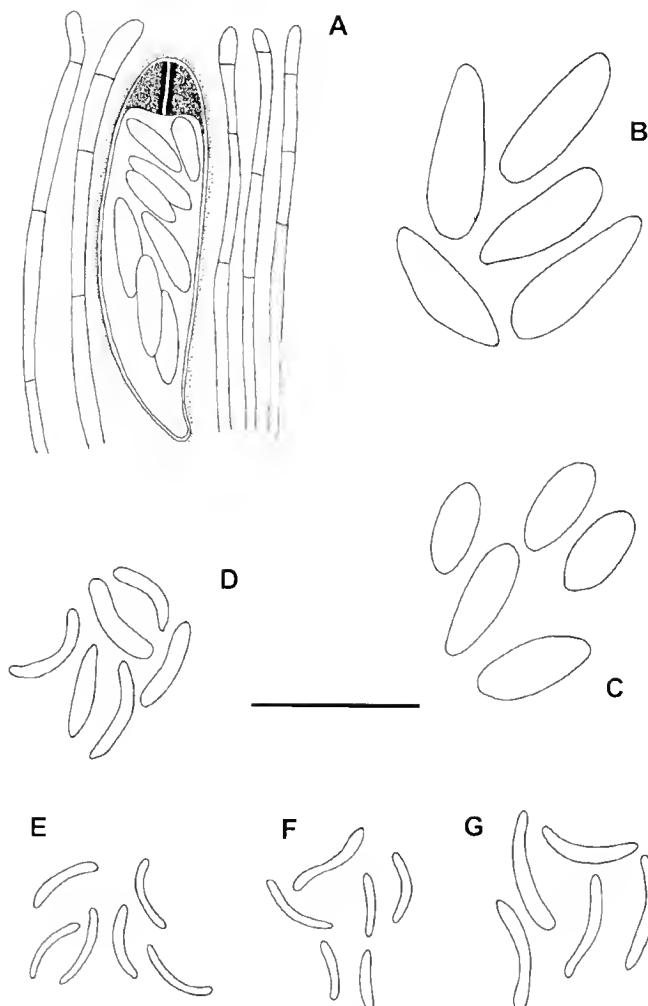
### Introduction

*Cladina* is primarily a southern Australasian lichen genus, with all of the nine species recognised by Filson (1992) occurring in that region. Of these, the most geographically restricted species are *C. ferdinandii*, which is found only in south-western Western Australia and southernmost South Australia, and *C. moniliformis*, which is endemic to south-western Tasmania. *Cladina fuliginosa* and *C. schizophora* also occur in South America, whilst *C. retipora* extends to New Caledonia. The most common and widespread species in the genus is *C. aggregata*, which has a southern circum-Pacific distribution, from Japan to Central America and the Caribbean, and also occurs in Madagascar and southern Africa.

In temperate regions of Australia, *C. aggregata* is found in virtually all vegetation types including coastal heathland, sclerophyll forest, rainforest, wet peatlands and alpine communities. It displays an often bewildering range of morphological and chemical variation and, in the past, numerous morphotypes have been accorded infra-specific rank (e.g. see Martin 1965). Galloway (1976) recognised one of the chemical-morphological variants as *C. inflata*, although Filson (1981) included this species within his concept of *C. aggregata* as a single, highly variable taxon. Kantvilas and Elix (1987) investigated the status of *C. inflata* and concluded that it was a distinct species, well separated from *C. aggregata* by morphology, chemistry and ascospore size. They also described a further, similarly distinguishable variant, *C. moniliformis*. Nevertheless, considerable variation remained within *C. aggregata* and *C. inflata* and further study of the morphology and chemistry of these species has revealed that they can be subdivided further. The results of these investigations are reported here.

### The *Cladina aggregata* complex: overview of the problem

The *Cladina aggregata* group is characterised by having very fragile, hollow pseudopodetia, and apothecia which proliferate and form tiers (see Filson 1981 and Henssen 1981 for discussion). The pseudopodetia are typically some shade of olive-green or olive-brown. The group includes *C. aggregata*, *C. inflata*, *C. moniliformis* and *C. schizophora*, and the four new taxa described below: *C. deformis*, *C. dumicola*, *C. mutabilis* and *C. oreophila*.



**Fig. 1.** Anatomy of *Cladonia*: **A** ascii, paraphyses and ascospores of *Cladonia dumicola*, amyloid areas without pretreatment in KOH stippled; **B** ascospores of *C. moniliformis*; **C** ascospores of *C. deformis*; **D** conidia of *C. deformis*; **E** conidia of *C. inflata*; **F** conidia of *C. dumicola*; **G** conidia of *C. moniliformis*. Scale = 12 mm.

The key characters for separating the species within the group are the general habit of the thallus (erect or decumbent, clumped or dispersed, etc.), the shape and branching pattern of both the sterile and fertile pseudopodetia, including the form of their apices and axils, and the medullary chemistry. These and other characters of the species treated in this paper are summarised in Table 1. Initially, the size of the ascospores and conidia appeared to provide useful characters also, but large numbers of measurements served only to blur any size disjunctions between species. With the exception of *C. moniliformis*, the ascospores of the other taxa tend to fall within the range of  $6-11 \times 2.5-4$   $\mu\text{m}$ , and size differences are related mainly to the stage of development of the apothecia and ascii rather than to the species involved. The same generally applies to conidia (Fig. 1).

Although the *C. aggregata* group is very widespread in the Southern Hemisphere and circum-Pacific regions, it is remarkable that most of the morphological and chemical variation is restricted to Tasmania. Five species (viz. *C. deformis*, *C. dumicola*, *C. moniliformis*, *C. mutabilis* and *C. oreophila*) are endemic to Tasmania, whilst

*C. inflata* occurs across southern Australasia but is most common in Tasmania. Even more remarkable is the fact that the endemic taxa (and much of the chemical variation) are confined to a very small region, namely the south-west, an area characterised by a flora rich in endemic angiosperms, gymnosperms and lichens (Kantvilas 1995).

At least some of the variability in the group is related to ecological factors. Thus inflated pseudopodetia tend to be found mostly in very wet habitats, with the most extreme form, the bulbous *C. moniliformis*, growing in the wettest, sometimes intermittently inundated, habitats, whereas the most slender forms of *C. aggregata* often occur in habitats most subject to drying out. Similarly, the water-repellant medullary compound, homosekikaic acid, is confined to *C. moniliformis*, the species most likely to be subjected to excessive hydration. Another hydrophobic compound, caperatic acid, is found only in *C. dumicola*, which occurs mainly in shaded habitats in very high rainfall areas. There remains the challenge to ascertain whether there is any adaptive significance in the distribution of the other chemical compounds.

The problem to be faced in the present project was to describe and partition the perplexing variation in a practical way. In past studies, such as on the genus *Siphula*, which shows a similar diversification in south-western Tasmania, chemistry provided a practical and unequivocal surrogate for interpreting the more subtle, morphological characters (Kantvilas 1996, 1998). Using this approach, we were alerted to the existence of *C. moniliformis* and *C. deformis*, two species easily recognised by morphological criteria also. However, limitations in the application of chemical characters were also encountered. Thus fumarprotocetraric acid, either alone or with its closely related derivatives, occurs virtually across the entire range of morphological variation exhibited by this species complex. Conversely, certain morphological types, such as the 'typical' *C. aggregata* form, span a wide range of chemotypes, such as those containing barbatic, fumarprotocetraric, stictic or psoromic acids. The approach of Filson (1981, 1992), where most of the variation in *C. aggregata* is encompassed within a single taxon, may be attractive for its convenience or simplicity. However, it is untenable in a region such as Tasmania, where it fails to account satisfactorily for the very obvious display of diversity in chemistry, morphology, anatomy and ecology, and of the links between these characters.

The present study is by no means a revision of the entire species complex, nor does it provide a solution to all the problems encountered. However, it identifies and segregates several well-defined entities in the group and attempts to summarise much of the variation as a basis for future studies.

## Materials and methods

Work is based primarily on the first author's collections at HO, gathered in the course of extensive field studies, mainly in western Tasmania. Anatomical observations of asci and ascospores were made on apothecial sections and squashes mounted in water or Lugol's iodine after pretreatment with 10% KOH, or in ammoniacal erythrocin. The Lugol's is recommended in cases where there tend to be very few mature asci (e.g. in *C. inflata*, *C. mutabilis* or *C. deformis*); sections containing only sterile asci show little or no amyloid reaction and can, therefore, be readily identified as useless. Conidia were observed exclusively in ammoniacal erythrocin. Chemical analyses were undertaken using standard methods (Culberson 1972; Elix and Ernst-Russell 1993; Feige *et al.* 1993). Grid zones used in species distribution maps represent 10,000 metre intervals of the Australian Map Grid, Zone 55, Universal Transverse Mercator Projection; these have been widely used in Tasmania for presenting distributions of native species and plant communities (e.g. Williams and Potts 1996).

Table 1. Salient features of species of the *Cladonia aggregata* complex (the uniquely sorediate *C. schizophora* is omitted).

	<i>C. aggregata</i>	<i>C. deformis</i>	<i>C. duunicola</i>	<i>C. inflata</i>	<i>C. moniliformis</i>	<i>C. mutabilis</i>	<i>C. oreophila</i>
Habit	erect, ascending or decumbent, in clumps, tufts or swards	± erect in loose clumps	± erect in loose tufts or clumps	decumbent and interwoven in clumps or mats	decumbent, usually ± dispersed	erect, in clumps or swards	erect, in swards or clumps
Surface (epitrichoid hair)							
Form	evenly cylindrical and tapered, occasionally inflated	unevenly inflated into irregular segments	not inflated, gradually tapering	inflated, ± evenly cylindrical	grossly inflated, with irregularly bulbous or cylindrical segments	slender and tapered or inflated, dimpled and puckered	inflated, unevenly cylindrical
Width	0.1–5 mm	1–7 mm	1–3 mm	1–4 mm	2–12 mm	0.4–5 mm	1–5 mm
Branching	repeatedly dichotomous or monopodial to sparsely dichotomous and with a main branch bearing short, stout laterals with deflexed apices	simple, or sparingly dichotomous at 15–45°	repeatedly dichotomous at <45°	repeatedly dichotomous at 35–90° usually at >90°, sometimes lobulate	simple or sparsely irregularly branched, usually at >90°	repeatedly di- or trichotomous at 20–45°	simple or sparsely dichotomous at 20–40°
Apices	glossy and usually smooth, pale yellow-green, olive-brown, chestnut-brown to blackish brown	smooth, ± glossy olive-brown to reddish brown	smooth, glossy olive-green to olive-brown	smooth to wrinkled, ± glossy, yellow-olive- to reddish brown	smooth, becoming ± scarid when old: yellow-brown to brown-black	smooth, ± glossy olive-brown to brown	mat, areolate, scabrid to bullate, pale grey to brownish
Surface and colour							
Anal s	not perforate; not constricted	perforate or not, mostly constricted	not perforate; not constricted	not perforate, not constricted	not perforate, not constricted	not perforate, not constricted	perforate, not constricted
Apices	nously tapered and acute, or very abruptly tapered to truncate, with awl-like pyrenidia	± rounded and blunt	acute to awl-like	truncate with needle-like pyrenidia	± rounded and blunt	acute to awl-like	abruptly tapered to a blunt point
Perforations	abundant	numerous	uncommon to abundant	few to absent	uncommon, often torn	numerous	absent to rare

Table I. Continued

	<i>C. aggregata</i>	<i>C. deformis</i>	<i>C. dinnicola</i>	<i>C. inflata</i>	<i>C. moniliformis</i>	<i>C. mutabilis</i>	<i>C. oreophila</i>
FERTILE PSEUDOPODETIA							
Form	more robust and taller than sterile pseudopodetia	more slender and more perforate than sterile pseudopodetia	similar to sterile pseudopodetia but more perforate	identical to sterile pseudopodetia	more slender and more perforate than sterile pseudopodetia	more robust, more inflated and taller than sterile pseudopodetia	not known
Branching	racemose	corymbose	racemose	dichotomous	racemose	mostly corymbose	not known
ASCOSPORES	(6–)7–11(–12) × 2.5–4 µm	6–9 × 2.5–4 µm	6.5–10 × 2.5–4 µm	8–10 × 3–4 µm	(8–)9–12 × 3–4.5 µm	8–10 × 3–4.5 µm	not known
CONDIA	5–8 × 0.6–1.5 µm	4.5–7 × 0.8–1.5 µm	5–7 × 0.6–1.5 µm	5–6 × 0.6–0.8 µm	6–10 × 0.6–1.5 µm	(5–)6–8(–10) × 0.8–1.5 µm	not known
CHEMISTRY							
	(a) barbatic, 4-O-demethyl-barbatic acids	stictic, constictic, cryptostictic (±), menegazziaic (±), succinoprotocetraric, protocetraric (±), succinoprotocetraric (±), physodalic (±) acids	caperatic, norcapерatic (±), ursolic (±) acids	fumaroprotocetraric, succinoprotocetraric (±), protocetraric (±), physodalic (±) acids	homosekkaic, sekkaic (±), ramalinolic (±), 4'-O-methylnorhomosekkaic (±) acids	fumaroprotocetraric acid	fumaroprotocetraric acid
	(b) fumaroprotocetraric, protocetraric (±), succinoprotocetraric (±), physodalic (±) acids	stictic, constictic, cryptostictic (±), norstictic (±), connorstictic (±), menegazziaic (±) acids					
	(c) stictic, constictic, cryptostictic (±), norstictic (±), connorstictic (±), menegazziaic (±) acids						
	(d) psoromic acid						
	(e) norstictic acid						
	(f) diffractaic acid						

### Generic characteristics

*Cladix* is characterised by a fruticose growth form, consisting of typically perforate pseudopodetia with an external cartilaginous layer. The apothecia are black or brown, with a prominent, persistent, proper margin and plane disc, eight-spored asci having a well-developed amyloid tholus with a darker staining central tube, stout, simple paraphyses and simple, hyaline ascospores (Fig. 1A). The pycnidia are immersed in glossy black to brown projections that are initially blunt and to c. 0.5 mm long, ultimately becoming needle-like or awl-like and to 1 mm long.

Following from the observations of Duvigneaud (1944), Galloway (1966) and Jahns (1972), Filson (1981) described a separate family, Cladiaceae, to accommodate the genus, chiefly on the basis of thallus and apothecial morphology. However, more commonly the genus is included in the Cladoniaceae (e.g. Hafellner 1988). Although it is not our intention to reassess the taxonomic position of *Cladix* here, it is significant that its ascus structure is of the typical *Cladonia*-type. Chemical composition in *Cladix* is also consistent with its inclusion in the Cladoniaceae.

### Key to species of the genus *Cladix*

1. Fertile pseudopodetia to 1.5 cm tall, internally sorediate, intermingled with markedly shorter, squamule-like, sterile pseudopodetia with sorediate apices, or arising from a sorediate crust of crowded, reduced pseudopodetia; W.A., S.A., Vic., N.S.W., A.C.T., Tas., N.Z., South America ..... *C. schizophora* (Nyl.) Nyl. 2
2. Pseudopodetia to 15 cm tall, not sorediate ..... 2
2. Pseudopodetia white to pale grey, occasionally in part faintly yellowish or pale brownish near the apices ..... 3
2. Pseudopodetia yellow-green, green, olive, brown or blackened ..... 5
3. Pseudopodetia with a compact, whitish inner medulla; perforations numerous and scattered, not forming a lace-like network; W.A., S.A., Qld, N.S.W., A.C.T., Vic. .... *C. corallaizon* F. Wilson ex Filson 4
3. Pseudopodetia hollow or with a stranded inner medulla; perforations very numerous, continuous and lace-like ..... 4
4. Pseudopodetia hollow; W.A., S.A. .... *C. ferdinaudi* (Müll. Arg.) Filson
4. Pseudopodetia with a stranded inner medulla; Qld, N.S.W., A.C.T., Vic., Tas., N.Z., New Caledonia ..... *C. retipora* (Labill.) Nyl. 5
5. Pseudopodetia with a compact, usually brown to black inner medulla ..... 6
5. Pseudopodetia hollow ..... 7
6. Cortex matt, crystalline, yellowish green to yellowish brown to blackened; W.A., N.S.W., Vic., Tas., N.Z., South America ..... *C. sullivanii* (Müll. Arg.) W. Martin
6. Cortex glossy, not crystalline, usually olive-brown to blackened; N.S.W., Vic., Tas., N.Z., South America ..... *C. fuliginosa* Filson
7. Cortex matt, areolate, scabrid to bullate; Tas. .... *C. oreophila* Kantvilas & Elix 8
7. Cortex matt or glossy, smooth ..... 8
8. Sterile pseudopodetia richly branched and tangled, forming spreading mats or cushions, very slender, mostly 0.5–1.5 mm thick; fertile pseudopodetia markedly more robust, to c. 5 mm thick; very common, polymorphic, and widespread on soil, rocks, bark or wood ..... *C. aggregata* (Sw.) Nyl.
8. Sterile pseudopodetia sparsely branched, ± discrete, mostly 1–12 mm thick, often inflated; fertile pseudopodetia generally similar to sterile pseudopodetia or more slender; ± exclusively on soil ..... 9

9. Medulla Pd- (lacking fumarprotocetraric acid) ..... 10
9. Medulla Pd+ red (containing fumarprotocetraric acid) ..... 12
10. Pseudopodetia grossly and irregularly inflated, with constricted axils and bulbous or cylindrical segments to 12 mm wide, typically rather decumbent and dispersed; containing homosekikaic acid; Tas. ..... *C. moniliformis* Kantvilas & Elix
10. Pseudopodetia  $\pm$  evenly cylindrical with unconstricted axils, to 5 mm wide,  $\pm$  erect in clumps ..... 11
11. Sterile pseudopodetia  $\pm$  monopodial, comprising  $\pm$  erect main branches with short laterals with deflexed apices diverging at  $>45^\circ$ ; apices of main branches abruptly tapered to  $\pm$  truncate; containing barbatic acid; widespread .. *C. aggregata* (Sw.) Nyl.
11. Sterile pseudopodetia dichotomously branched at  $<45^\circ$ , with all branches gradually tapered to  $\pm$  erect, acute to awl-like apices; containing caperatic acid; Tas. ..... *C. dumicola* Kantvilas & Elix
12. Sterile and fertile pseudopodetia  $\pm$  identical, decumbent, forming interwoven clumps or mats; perforations virtually absent, at least on the 'upper surface'; apices truncate; W.A., N.S.W., Tas., N.Z. ..... *C. inflata* (F. Wilson) D.J. Galloway
12. Sterile pseudopodetia  $\pm$  erect,  $\pm$  discrete in loose clumps; perforations numerous; apices rounded to awl-like, not truncate; fertile pseudopodetia morphologically distinct ..... 13
13. Sterile pseudopodetia with  $\pm$  constricted axils, unevenly inflated segments and  $\pm$  rounded, blunt apices; fertile pseudopodetia more slender than sterile pseudopodetia; containing stictic and fumarprotocetraric acids; Tas. .... *C. deformis* Kantvilas & Elix
13. Sterile pseudopodetia with axils unconstricted, evenly tapered or inflated; apices acute to awl-like; fertile pseudopodetia more robust and more inflated than sterile pseudopodetia; lacking stictic acid ..... 14
14. Sterile pseudopodetia inflated or, if not inflated, sparingly dichotomously branched to c. 1–3 times; fertile pseudopodetia corymbose; Tas. .... *C. mutabilis* Kantvilas & Elix
14. Sterile pseudopodetia never inflated, richly branched and entangled to c. 6 times; fertile pseudopodetia racemose; Tas., N.Z., South America, New Caledonia ..... *C. aggregata* (Sw.) Nyl.

## Taxonomy

1. *Cladia aggregata* (Sw.) Nyl., *Compt. Rend. Hebd. Séances Acad. Sci.* 83: 88 (1876). *Lichen aggregatus* Sw., *Prodri.* 147 (1788). *Type:* Jamaica, O.P. Swartz. (lectotype, *fide* Filson 1981: S, n.v.).

For synonyms see Filson (1981).

*Sterile pseudopodetia* very variable, erect, ascending or decumbent, forming clumps, tufts or swards, decaying at the base, evenly cylindrical, most commonly not inflated and tapering to acute or awl-like apices, rarely inflated and then  $\pm$  truncate and tapering rather abruptly, (3–)10–80(–110) mm tall, (0.1–)0.5–1.5(–5) mm wide; surface pale yellow-green, green, olive or chestnut-brown to blackish brown, smooth and glossy, rarely somewhat dimpled, striate and chinky in older inflated thalli; branching rather variable, typically repeatedly dichotomous or rarely trichotomous, with branches densely entangled, or occasionally (in erect, inflated, alpine forms) monopodial, with a sparsely branched main axis bearing numerous short laterals; axils closed, not constricted, angles variable, with major branches diverging mostly at 45–90° but short laterals diverging at  $>90^\circ$ ; perforations very sparse to numerous, scattered or to one side of the pseudopodetia, slit-like to roundish or oval, (0.1–)0.5–3 mm wide; medullary cavity white, farinose.

*Fertile pseudopodetia* erect or, in epiphytic specimens, decumbent, typically more robust and taller than sterile pseudopodetia, mostly 1.5–3.5(–5) mm wide, 12–80 mm tall; branching racemose or occasionally  $\pm$  corymbose; perforations abundant, 0.2–1.5 mm wide, sometimes forming a lace-like network in the upper part. *Apothecia* apical on short branchlets, 0.1–0.2 mm wide when well developed, proliferating in up to 6 tiers, clustered in groups of up to c. 12(–20). *Ascospores* ellipsoid, (6)–7–11(–12)  $\times$  2.5–4  $\mu\text{m}$ . *Pycnidia* common, at the apices of sterile pseudopodetia or on the lower laterals of fertile pseudopodetia. *Conidia* filiform to narrowly fusiform, straight or more commonly bent, 5–8  $\times$  0.6–1.5  $\mu\text{m}$ . (Fig. 2)

*Chemistry:* six chemical races are known and are treated separately below:

- (i) barbatic and 4-*O*-demethylbarbatic acids
- (ii) fumarprotocetraric, protocetraric ( $\pm$ ), succinprotocetraric ( $\pm$ ), physodalic acids ( $\pm$ )
- (iii) stictic, constictic, cryptostictic ( $\pm$ ), norstictic ( $\pm$ ), connorstictic and menegazziaic ( $\pm$ ) acids
- (iv) psoromic acid
- (v) norstictic acid
- (vi) diffractaic acid (major), 4-*O*-demethyldiffractaic acid (minor).

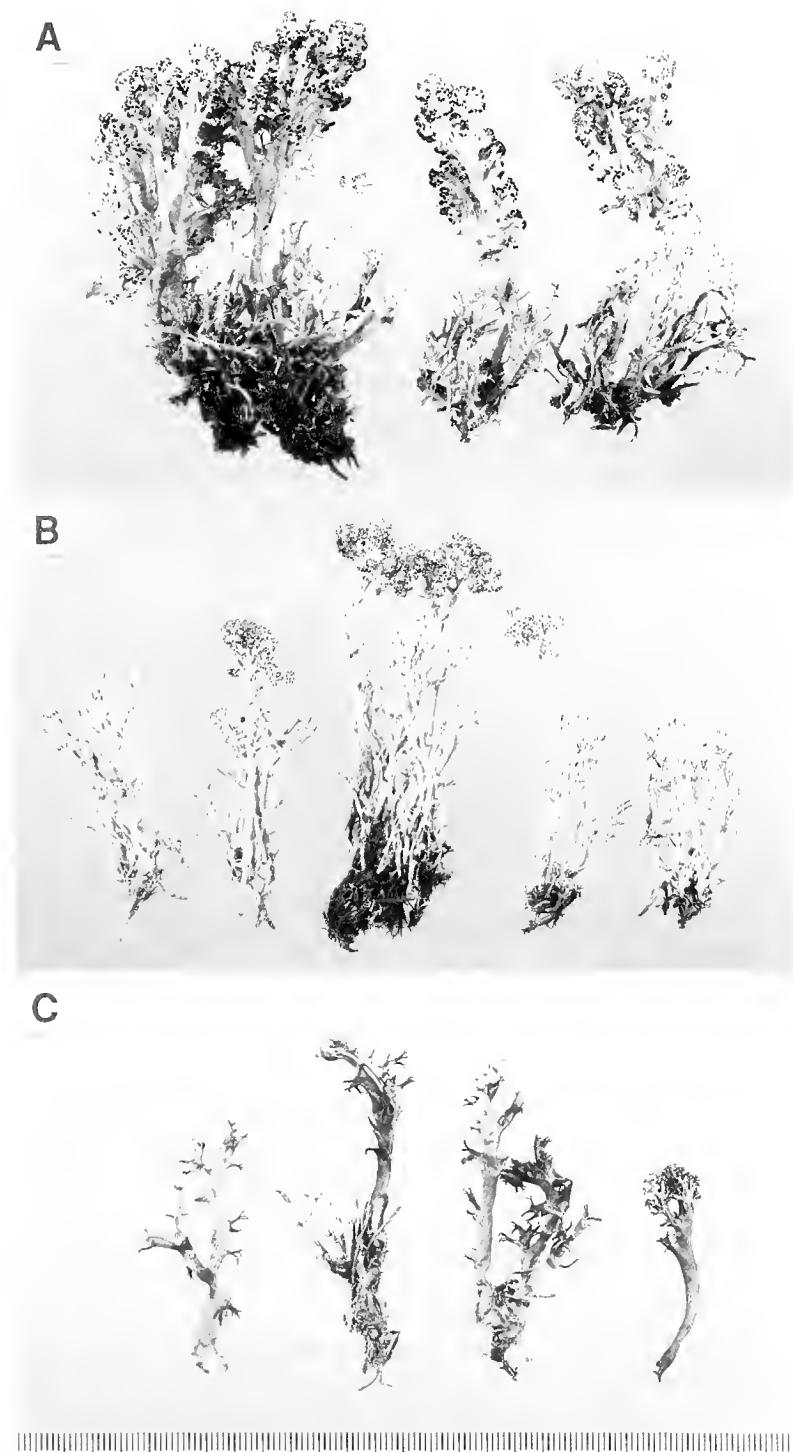
*Remarks:* *Cladonia aggregata* is an extremely variable species morphologically, and this variation is matched by its chemical diversity, wide ecological amplitude and extensive geographic distribution. The large number of taxonomic synonyms described for this species (Filson 1981) reflects this variability and the extent to which it has perplexed botanists in the past. It is significant that most of the variability is expressed only in Tasmania or in the southern Australasian region; further afield, *Cladonia aggregata* is a relatively straightforward taxon with consistent chemical composition comprising barbatic acid. There is some confusion regarding the size of the spores of this species. Filson (1981, 1994) and other authors give these as 12–15  $\mu\text{m}$  long, but we have not seen any spores longer than 12  $\mu\text{m}$  and most are shorter than 10  $\mu\text{m}$ .

We have found no correlations between chemical composition and morphological, spore and conidial characters. Whilst there are many precedents for recognising the chemical races at infraspecific rank (as, for example, has occurred in several species of *Cladonia*), we have refrained from this course pending further study, but discuss the races separately below.

#### 1a. The barbatic acid race

This race represents *C. aggregata* in the strictest sense, and in its 'typical' form is characterised morphologically by highly branched and entangled,  $\pm$  cylindrical and evenly tapered, narrow, sterile pseudopodetia and markedly stouter, taller, erect, generally racemose fertile pseudopodetia. Sometimes it also occurs as a sward of fertile pseudopodetia. This race encompasses a fascinating range of morphologies. At one extreme are thalli with dark chestnut to blackish brown, very narrow, decumbent, sterile pseudopodetia, almost devoid of perforations; such forms are very similar to *Coelocaulon aculeatum* (Schreb.) Link (Parmeliaceae) and have been misidentified as such by many botanists, especially those unfamiliar with Australasian lichens. At the other extreme are very robust,  $\pm$  inflated, erect, scarcely branched, monopodial forms, found mostly in alpine habitats. In between there is a continuum of variation in thallus colour, branch thickness and growth form. Unlike the fumarprotocetraric acid-containing populations of *Cladonia* where morphological disjunctions are discernible and underpin taxonomic entities, in our opinion, the barbatic acid race defies further subdivision.

*Cladonia aggregata* in the strict sense is usually well separated from its relatives both chemically and morphologically. These other taxa have either bulbous, inflated (rather than cylindrical) fertile pseudopodetia, or sterile pseudopodetia quite unlike those of *C. aggregata*. Inflated forms of *C. aggregata* (Fig. 2C) tend to be particularly distinctive



**Fig. 2.** Morphological variation in *Cladonia aggregata*. A typical robust fertile pseudopodetia containing fumarprotocetraric acid (Kantvilas 71/98); B erect sterile and fertile pseudopodetia containing fumarprotocetraric acid (Kantvilas 69/98); C alpine, inflated form containing barbatic acid (Kantvilas 162/86). Scale in mm.

and the possibility of confusion with the other taxa with inflated pseudopodetia is slight. Such forms are characterised by erect, clump-forming sterile pseudopodetia to 80 mm tall and to 5 mm wide, with a glossy, pale olive-green to olive-brown to chestnut-brown cortex. In older thalli, the cortex may become striate or even rather chinky. Although occasionally dichotomously branching, this form is essentially monopodial, with erect main branches bearing stout, short laterals diverging at rather broad angles (from 50° to >90°) and tapering to awl-like, deflexed apices. The 'internodes' between the laterals may be up to 15 mm long, accentuating the 'monopodial' growth form. This very distinctive branching pattern makes this taxon readily recognisable in the field. The apices of the main branches tend to be tapered rather abruptly and are somewhat truncate (a little like those in the decumbent *C. inflata*), but are also terminated by about 4 pairs of needle-like or awl-like pycnidia. The axils are closed and not constricted, perforations are abundant and scattered, and the medullary cavity is persistently white and tomentose to farinose. Fertile pseudopodetia are very rare in this form but pycnidia are abundant.

*Distribution and ecology:* This is overwhelmingly the most common race of the species and occurs across the entire range of the genus, from southern Africa and Madagascar, East Asia as far north as Japan, Australasia, South and Central America and the West Indies. In Australia and Tasmania, it occurs in virtually all vegetation types and habitats, including arid rangelands, savannah-like eucalypt woodlands, dry and wet sclerophyll forests, cool temperate rainforest, moorlands, heathlands and alpine vegetation. It occurs as an epiphyte, and on wood, rock or on soil. The erect, inflated morphotype is known only from Tasmania where it is found mostly in alpine or subalpine heathland and moorland, associated with *C. sullivani*, *C. retipora*, *C. fuliginosa*, *C. inflata*, *Cladonia southlandica*, *C. murrayi* and *Siphula decumbens*. Occasionally it also occurs at lower altitudes in some buttongrass moorland communities where it is associated with *Cladonia moulliforuis*, *C. unitabilis*, *C. deformis*, *Siphula decumbens* and *S. jamesii*. (Fig. 3A)

Selected specimens examined (total = 217): AUSTRALIA, TASMANIA: near Collinsvale, 42°51'S, 147°12'E, L. Rodway s.n., May 1891 (HO); Deep Creek track, Mt Wellington, 42°56'S, 147°14'E, 480 m a.s.l., W.A. Weymouth 639, 23 Jan. 1899 (HO); Kingston, 42°59'S, 147°18'E, W.M. Curtis s.n., Apr. 1951 (HO); Mt Victoria Track, 880 m a.s.l., G. Kantvilas 51/81, 21 Feb. 1981 (BM, HO); The Clump, 41°12'S, 144°52'E, 150 m a.s.l., A. Moscal 4682, 9 Dec. 1983 (HO); The Knob, 42°44'S, 145°58'E, 440 m a.s.l., G. Kantvilas 191/95, 5 Dec. 1995 (HO); Dove Lake, 41°40'S, 145°58'E, 960 m a.s.l., G. Kantvilas s.n., 3 June 1986 (HO); Adamsons Peak, 43°21'S, 146°49'E, 930 m a.s.l., G. Kantvilas 162/86, 21 Sep. 1986 (HO); Mt Field West Plateau, 42°49'S, 146°31'E, 1400 m a.s.l., G. Kantvilas 44/80, 11 Mar. 1980 (HO); Scotts Peak Road near the airstrip, 43°02'S, 146°19'E, 340 m a.s.l., G. Kantvilas 101/95, 21 Sep. 1995 (HO); Lake Skinner, 42°57'S, 146°41'E, 960 m a.s.l., G. Kantvilas 77/80, 4 Apr. 1980 (HO); Mt Wedge, 42°51'S, 146°18'E, 1140 m a.s.l., G.C. Bratt & F.N. Lakin 71/1628, 4 Dec. 1971 (HO); Trevallyn SRA, 41°27'S, 147°06'E, 200 m a.s.l., A.V. Ratkowsky s.n., 12 Feb. 1992 (HO).

## 1b. The fumarprotocetraric acid race

The morphology and anatomy of this race fall entirely within the range of that of the barbatic acid race, although with considerably less variation. Its sterile pseudopodetia are typically erect or ascending, highly branched and entangled, not inflated, mostly 0.5–1.5 mm wide and up to 80 mm tall, pale yellowish green to brown, rarely if ever dark chestnut-brown or blackened, and taper gradually to an acute apex. The branches sometimes tend to diverge at rather acute angles (c. 45°), whereas in the barbatic acid race most of the laterals diverge at angles of >90°. This subtle character is not consistent, however. As in the barbatic acid race, the fertile pseudopodetia are racemose, generally taller and more robust than the sterile pseudopodetia, and sometimes form extensive swards. This race never occurs as the blackened, decumbent, narrow-entangled

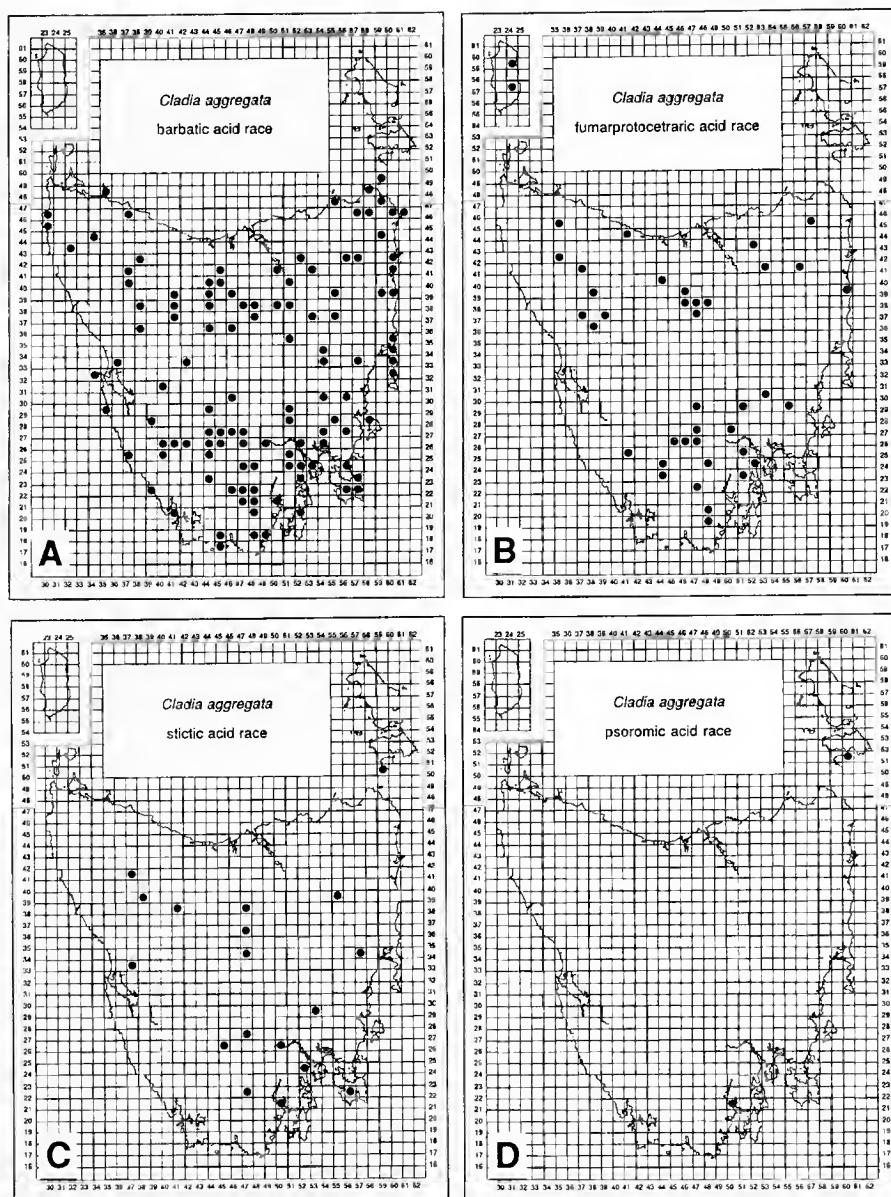


Fig. 3. Distribution of the chemical races of *Cladonia aggregata* in Tasmania. A barbatic acid race; B fumarprotocetraric acid race; C stictic acid race; D psoromic acid race.

*Coelocaulon*-like form, nor as the erect, grossly inflated, monopodial forms.

Separation of this race of *C. aggregata* from other species of *Cladonia* that contain fumarprotocetraric acid is usually straightforward. Only *C. inflata* consistently approaches it in branching pattern, but that species is recognised by the inflated sterile pseudopodetia, its usually decumbent habit, the virtual absence of perforations, and the morphology of the fertile pseudopodetia which are identical to the sterile ones. *Cladonia deformis* and *C. oreophila* also differ from this race by having inflated pseudopodetia, the former also differing chemically, and the latter also having an areolate cortex. It is more difficult to

distinguish this race from *C. mutabilis* which may or may not be inflated; uninflated forms of that species differ by having very sparingly branched sterile pseudopodetia (usually 1–3 times instead of up to 6) and corymbose fertile pseudopodetia.

*Distribution and ecology:* This race is known mainly from Tasmania, with single collections from Antipodes Island and New Caledonia. Galloway (1985) implies that it may also be present in New Zealand, although this was not confirmed in the present study, whilst Ahti and Kashiwadani (1984) and Stenroos *et al.* (1992) record it from southern Chile. The latter authors also record a race comprising fumarprotocetraric acid together with barbatic acid, an unusual combination which we have never observed in our studies. It grows in a very wide range of habitats from lowland to alpine altitudes, in sclerophyll forest, cool temperate rainforest, buttongrass moorland, heathland and alpine vegetation. Most specimens are terricolous, but it also occurs on wood or as an epiphyte. (Fig. 3B)

*Selected specimens examined* (total = 47): AUSTRALIA, TASMANIA: Mt Wellington, The Springs, 720 m a.s.l., R.D. Seppelt 19310, 18 Feb. 1994 (HO); Liffey Bluff, 41°43'S, 146°47'E, 900 m a.s.l., A. Moscal 17704, 23 Apr. 1989 (HO); Scotts Peak Road near the airstrip, 43°02'S, 146°19'E, 340 m a.s.l., G. Kantvilas 102/95, 21 Sept. 1995 (HO); King Island, Pegarah Forestry Reserve, 39°56'S, 144°00'E, I.D. Cameron s.n., 13. June 1965 (HO); near Dunrobin Bridge, 42°32'S, 146°44'E, G.C. Bratt 67/48, 30 July 1967 (HO); Savage River Pipeline, south of Rapid River, 41°16'S, 145°19'E, 480 m a.s.l., G. Kantvilas 728/80, 27 Nov. 1980 (BM, HO); Anthony Road, 41°49'S, 145°38'E, 450 m a.s.l., G. Kantvilas 164/97, 6 May 1997 (HO); continuation of Lonnavaile Road, 42°58'S, 146°48'E, G.C. Bratt 69/818, 26 Oct. 1969 (HO); Mother Cummings Peak, 41°40'S, 146°32'E, 850 m a.s.l., A. Moscal 12347, 20 Feb. 1986 (HO); Adamsons Peak, 43°21'S, 146°49'E, 930 m a.s.l., G. Kantvilas 163/86, 21 Sep. 1986 (HO). NEW ZEALAND, ANTIPODES ISLAND: south side of Hut Cove, [75–90 m a.s.l.], R.C. Harris 5820, 16 Feb. 1970 (HO, MSC). NEW CALEDONIA: summit of Mt Bou, 1050 m a.s.l., B.M. Potts s.n., 21 Feb. 1991 (HO).

### 1c. The stictic acid race

This race also falls within the range of morphological and anatomical variation of the barbatic acid race. In most specimens, the sterile pseudopodetia are typically rather narrow and 0.4–1 mm wide, uninflated, evenly tapered, pale yellow-green to chestnut-brown and glossy. Whilst some are ± erect and have acute-angled axils, others are decumbent with broadly divergent lateral branches. Some sterile specimens, especially ones from high altitudes, are rather distinctive and resemble *C. dunicala*, having sparsely branched pseudopodetia. These may well represent a distinct taxon, but on the collections available, it has been difficult to circumscribe such an entity other than by using chemical characters. Stictic acid also occurs in *C. deformis*, which in addition contains fumarprotocetraric acid and has grossly inflated pseudopodetia with constricted axils and internodes.

*Distribution and ecology:* This uncommon race is known from Tasmania, Victoria, the Furneaux Islands, Macquarie Island and New Zealand. It too displays a very wide ecological amplitude, ranging from lowland to alpine altitudes and from the high rainfall areas of western Tasmania to the drier parts of the east. All collections are from soil in open habitats in moorland and heathland. (Fig. 3C)

*Selected specimens examined* (total = 21): AUSTRALIA, TASMANIA: south of Que River, 41°35'S, 145°40'E, 650 m a.s.l., G. Kantvilas s.n., 22 May 1986 (HO); Lake Dove, 41°40'S, 145°58'E, G. Kantvilas s.n., 3 June 1986 (HO); track to Beatties Tarn, 42°41'S, 146°39'E, 920 m a.s.l., G.C. Bratt & J.A. Cashin 421, 18 Aug. 1963 (HO); 2 km west of New Norfolk, 42°47'S, 147°02'E, 90 m a.s.l., G. Kantvilas s.n., 19 Feb. 1997 (HO); Mount Koonya, 43°06'S, 147°48'E, 300 m a.s.l., A. Moscal 5211, 1 Jan. 1984 (HO); Bass Strait, Clarke Island, 55 m a.s.l., J.S. Whinray 1513, 30 June 1981 (HO, MEL). VICTORIA: Great Western, 37°09'S, 142°52'E, G.C. Bratt 67/119, 30 Sep. 1967 (HO). NEW ZEALAND: Foggy Peak, 43°17'S, 171°45'E, G.C. Bratt 72/1897, 12 Nov. 1972 (HO). MACQUARIE ISLAND: Razor Back Ridge, 54°34'S, 158°57'E, R.D. Seppelt 15402, 11 Feb. 1985 (HO).

### 1d. The psoromic acid race

This very rare chemotype is known only from two, small, fragmented specimens from gritty, quartzitic soil in lowland heathland. Both have sterile pseudopodetia which are decumbent, only 0.3–0.5 mm wide, glossy chestnut-brown, taper evenly to a point, and are sparsely branched with axillary angles ranging from acute to obtuse. Well-developed fertile pseudopodetia have not been seen, but the few spores observed are 8–10 × 3 µm and thus identical with those of the other races of *C. aggregata*. (Fig. 3D)

*Specimens examined:* AUSTRALIA, TASMANIA: Randalls Bay, 43°15'S, 147°08'E, G.C. Bratt & K.M. Mackay 69/407, 18 May 1969 (HO); Bass Strait, Clarke Island, 46 m a.s.l., J.S. Whinray 1402, 24 Mar. 1980 (HO, MEL).

### 1e. The norstictic acid race

This rare chemotype is known from a single collection from arid south-western Western Australia where it grew on soil. It has a *Coelocaulon*-type morphology of brown, narrow, entangled sterile pseudopodetia with broadly diverging branches.

*Specimen examined:* AUSTRALIA, WESTERN AUSTRALIA: Kondinin Forestry Reserve, 32°30'S, 118°24'E, 300 m a.s.l., G.C. Bratt 67/367 (HO).

### 1f. The diffractaic acid race

This rare chemotype is known from a single collection from sandstone in open eucalypt woodland in New South Wales. It was not available for study.

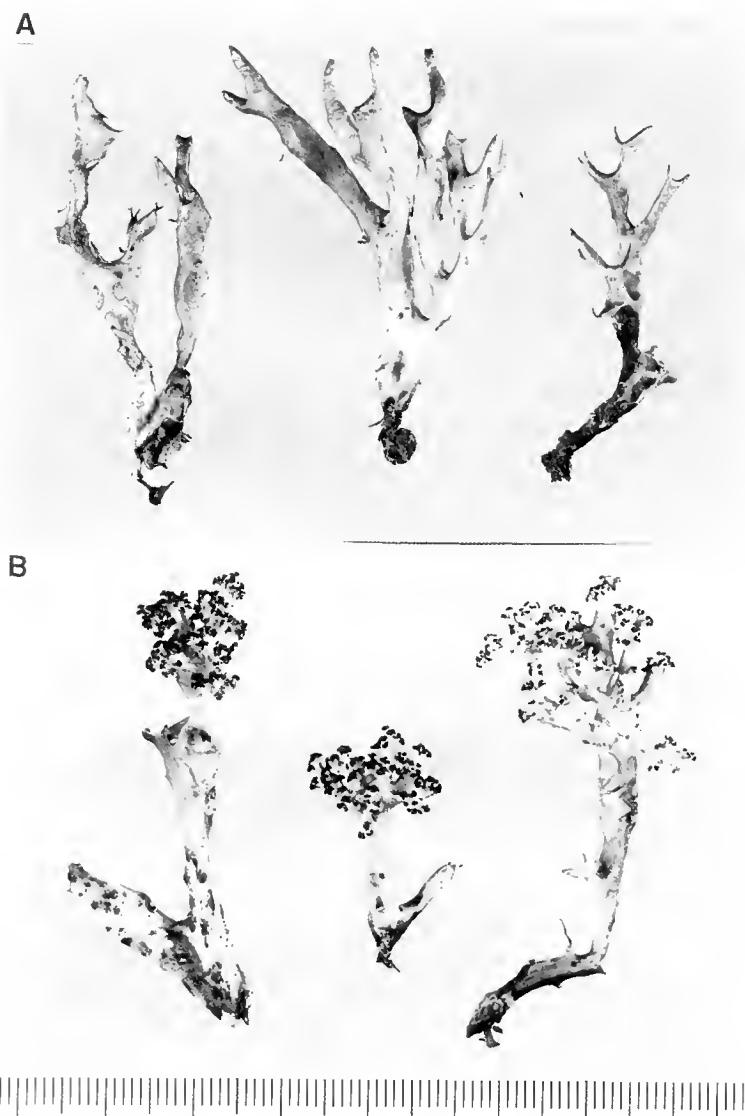
*Specimen examined:* AUSTRALIA, NEW SOUTH WALES: Morton National Park, 8 km NE of Nerriga, 35°07'S, 150°08'E, J.A. Elix 5089, 31 Oct. 1978 (MEL).

## 2. *Cladonia deformis* Kantvilas & Elix sp. nov.

Species *Cladiae moniliformi* aliquantum similis, pseudopodetiis sterilibus valde inflatis et axillis constrictis, sed acidum sticticum et acidum fumarprotocetraricum continens, habitu erectiore fasciculatoque et segmentis elongatioribus.

*Type:* Tasmania, Scotts Peak Road near airstrip, 43°02'S, 146°19'E, on wet peaty soil in buttongrass moorland, 340 m a.s.l., 8 Mar. 1991, G. Kantvilas 87/91 (holotype HO).

*Sterile pseudopodetia* ± erect, forming loose clumps, decaying at the base, unevenly inflated, puckered and dimpled, and somewhat constricted into irregular, elongate segments, 35–50 mm tall, (1–)2–5(–7) mm wide, simple or sparingly dichotomously branched, generally with apices ± rounded and blunt, or with occasional awl-like pycnidia; surface smooth to slightly wrinkled in older parts, often rather glossy, typically olive-brown to reddish brown, tending to pale olive-greenish in shade, blackened near the base; axils of main branches open or closed, forming angles of 15–45° (occasional short laterals diverging at up to 90°), generally ± constricted; perforations 0.3–3 mm wide, usually numerous, roundish to oval, sometimes torn, often mainly towards one side of the pseudopodetia; medullary cavity farinose, white, or brownish where exposed. *Fertile pseudopodetia* not common, similar in size and form to sterile pseudopodetia, or somewhat more slender, typically more perforate and corymbose towards the apices, ± discrete or arising as laterals from sterile pseudopodetia. *Apothecia* apical, 0.1–0.2 mm wide, glossy, with a dark red-brown proper margin and black disc, typically clustered in loose groups of 2–7(–9), single or two-tiered. *Ascospores* ellipsoid or tapered somewhat at one end, 6–9 × 2.5–4 µm. *Pycnidia* occasional, usually single on short lateral branches, at the apices of main branches of sterile pseudopodetia or, rarely, on fertile



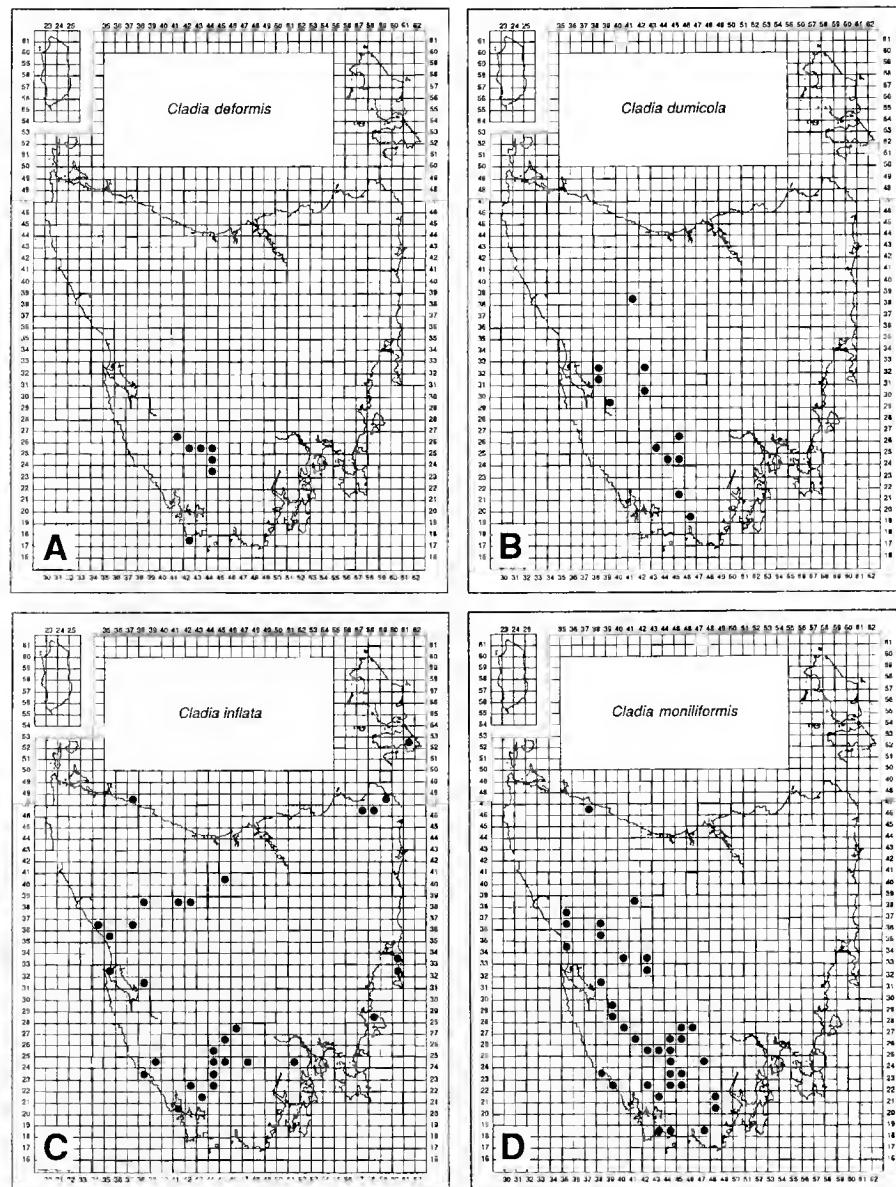
**Fig. 4.** *Cladonia deformis* (Kantvilas 70/98). **A** sterile pseudopodetia; **B** fertile pseudopodetia. Scale in mm.

pseudopodetia. Conidia fusiform to filiform, with blunt apices, straight, sigmoid or curved, 4.5–7 × 0.8–1.5 µm. (Figs 1C–D, 4)

*Chemistry:* stictic acid, constictic acid, cryptostictic acid ( $\pm$ ), menegazziaic acid ( $\pm$ ), fumarprotocetraric acid, succinprotocetraric acid ( $\pm$ ), protocetraric acid ( $\pm$ ); medulla Pd+ red, K-, KC-, C-, UV-.

*Remarks:* *Cladonia deformis* is characterised unequivocally by the combination of a grossly inflated thallus and the presence of stictic acid in the medulla. However, the concentration of this compound is not sufficiently high to be detectable with certainty by means of a spot test with KOH. Indeed in one specimen, which on the basis of morphology alone clearly belonged to *C. deformis*, we were able to detect stictic acid only in the very apices of the pseudopodetia but nowhere else in the thallus.

The new species is rather variable and its morphology may overlap to some extent that of other related species. Its constricted axils and semi-constricted, unevenly 'segmented' internodes ally it most closely with *C. moniliformis*. However, in addition to containing homosekikaic acid, *C. moniliformis* differs in having much more bulbous pseudopodetal segments (in *C. deformis* they are unevenly elongate), and a dispersed, prostrate habit. In contrast, *C. deformis* tends to form semi-erect clumps. The two species also differ somewhat in their colour and surface texture: *C. deformis* tends to be a glossy reddish brown, whereas *C. moniliformis* is yellow-brown to blackened, and matt at least in older



**Fig. 5.** Distribution of species of *Cladia* in Tasmania. **A** *C. deformis*; **B** *C. dumicola*; **C** *C. inflata*; **D** *C. moniliformis*.

parts of the thallus. When fertile, *C. deformis* is distinguishable from *C. moniliformis* by the generally more robust and essentially corymbose fertile pseudopodetia (in *C. moniliformis* these are quite slender and rather racemously branched) and by its smaller spores.

Also potentially similar are some of the forms of *C. mutabilis*, which may also have grossly inflated, rather bulbous pseudopodetia. In this case, these two taxa can be separated morphologically, in that the sterile pseudopodetia of *C. deformis* tend to have blunt to  $\pm$  rounded apices whereas those of *C. mutabilis* may be rather pointed and tapered. *Cladina deformis* also tends to have larger, more prominent perforations. Its fertile pseudopodetia are usually rather slender in comparison with the sterile ones, whereas in the potentially similar forms of *C. mutabilis*, the fertile pseudopodetia are more robust. Fertile material is not common in *C. deformis* but, unlike in *C. mutabilis*, well developed asci containing mature spores were located without much difficulty. Apothecia appear to be rarely tiered, and consist at most of two compressed 'strata'. Although overlapping in size, the spores of *C. deformis* tend to be somewhat smaller than those of *C. mutabilis*.

*Distribution and ecology:* *Cladina deformis* is endemic to Tasmania where it is confined to the south-west, exclusively to areas with a Precambrian geology (Fig. 5A). It occurs on peaty or gravelly soil in buttongrass moorland, usually in the most depauperate sites where drainage is poorest, the soil is thin and the cover of vascular plants is sparse. It ranges from sea-level to subalpine altitudes.

Although it co-occurs geographically and ecologically with the related and somewhat similar species *C. moniliformis*, *C. deformis* appears to be much rarer and more restricted. Despite extensive sampling of *Cladina* populations across many areas of the southwest, it appears to be locally abundant mainly in the Gordon River-Scotts Peak area. Other lichens with which it is associated include *Cladina inflata*, *C. aggregata*, *C. retipora*, *C. sullivani*, *Cladonia southlandica*, *Siphula jamesii* and *S. decumbens*.

*Specimens examined:* AUSTRALIA, TASMANIA: Scotts Peak Road near Clear Creek, 42°53'S, 146°23'E, 360 m a.s.l., G. Kantvilas 99/95, 100/95, 21 Sep. 1995 (HO); Wilsons Bight, 43°32'S, 146°05'E, 30 m a.s.l., A.M. Buchanan 9421, 13 Jan. 1987 (HO); Edgar Lake, 43°01'S, 146°20'E, G.C. Bratt et al. 70/1200, 11 Oct. 1970 (HO); Wedge River, 42°51'S, 146°14'E, 360 m a.s.l., G.C. Bratt 68/220a, 15 Mar. 1968 (HO); Condominium Creek, 42°57.5'S, 146°21.5'E, 360 m a.s.l., G. Kantvilas s.n., 28 Aug. 1986 (HO); Scotts Peak Road near airstrip, 43°02'S, 146°19'E, 340 m a.s.l., G. Kantvilas 104/95, 105/95, 21 Sep. 1995 (HO); Mt Sprent, 42°48'S, 145°58'E, 700 m a.s.l., G. Kantvilas s.n., 31 Jan. 1987 (HO); The Knob, 42°44'S, 145°58'E, G. Kantvilas s.n., 28 Aug. 1986 (HO); near The Hermit, 42°49'S, 146°08'E, 320 m a.s.l., G. Kantvilas 192/95, 5 Dec. 1995 (HO); 1.5 km SE of McPartlan Pass, 42°52'S, 146°12'E, 330 m a.s.l., G. Kantvilas 195/95A, 5 Dec. 1995 (HO); Red Knoll, 43°02'S, 146°17'E, 440 m a.s.l., G. Kantvilas 70/98, 3 Feb. 1998 (HO).

### 3. *Cladina dumicola* Kantvilas & Elix sp. nov.

Species *Cladiae aggregatae* *Cladiae inflataeque* manifeste affinis sed acidum caperaticum continens et pseudopodetiis nitidis olivaceis, comparate gracilibus, non inflatis, acutangulatis ramosis, concinne decrescentibus, ascosporis ellipsoideis, 6.5–10  $\mu$ m longis, 2.5–3.5  $\mu$ m latis, et conidiis filiformibus, 5–6.5  $\mu$ m longis, 0.6  $\mu$ m latis.

*Type:* AUSTRALIA, TASMANIA, Condominium Creek, 42°58'S, 146°22'E, on peat in buttongrass moorland, 330 m a.s.l., 28 Aug. 1986, G. Kantvilas s.n. (holotype HO).

*Sterile pseudopodetia*  $\pm$  erect, forming loose tufts or compact clumps, decaying at the base, 30–60 mm tall, 1–3 mm wide, not inflated, tapered gradually to acute or awl-like apices,  $\pm$  regularly dichotomously branched (up to c. 6 times); surface smooth and glossy, olive-green to olive-yellow, to olive-brown in exposed habitats, usually dark brown to black near the base; axils neither perforate nor constricted, acute, forming angles  $<45^\circ$ , perforations round to oval, 0.2–1.5 mm wide, uncommon, scattered or abundant, but then usually concentrated in a single rank along one side of the pseudopodetia or near their

apices; medullary cavity white and tomentose throughout. *Fertile pseudopodetia* similar in size and form to sterile pseudopodetia, except usually more densely branched near the apices and with more abundant perforations, racemose. *Apothecia* apical, to 0.2 mm wide, black and glossy, with a prominent, persistent proper margin and plane,  $\pm$  sunken disc, occurring singly or in clusters of 2–5 per branch, occasionally proliferating in rather compressed tiers. *Ascospores* ellipsoid, 6.5–10  $\times$  2.5–4  $\mu\text{m}$ . *Pycnidia* common, occurring singly or in pairs, mostly at the apices of sterile pseudopodetia or, occasionally, amongst the apothecia on fertile pseudopodetia. *Conidia* filiform, with blunt apices, straight or curved, 5–7  $\times$  0.6–1.5  $\mu\text{m}$ . (Figs 1A, 1F, 6)

*Chemistry*: caperatic acid, norcaperatic acid ( $\pm$ ), ursolic acid ( $\pm$ ); medulla K-, Pd-, KC-, C-, UV-.

*Remarks*: *Cladonia dumicola* is a very distinctive species, characterised morphologically by its relatively slender, elongate, glossy olive-coloured pseudopodetia. As with most *Cladonia* species, medullary chemistry is a critical aid to identification and, in this case, *C. dumicola* is unique in the *C. aggregata* complex in containing fatty acids.

Although previously included by us within a rather broad concept of *C. inflata* (Kantvilas and Elix 1987), the new species has pseudopodetia which, although at times rather robust, are not markedly inflated, but are relatively neatly tapered and cylindrical.

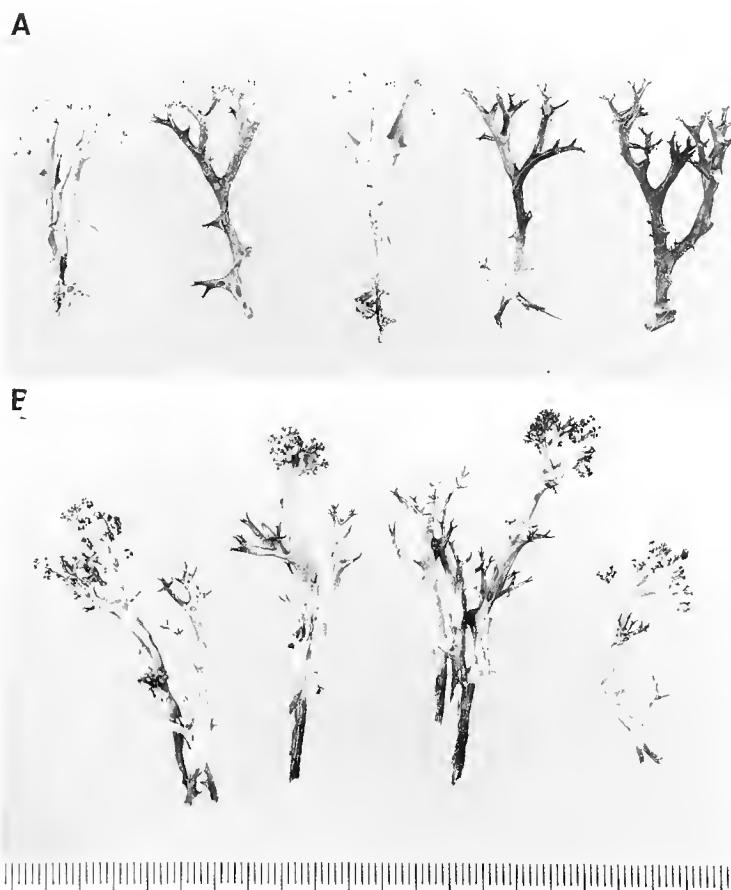


Fig. 6. *Cladonia dumicola* (Kantvilas 72/98). A sterile pseudopodetia; B fertile pseudopodetia. Scale in mm.

It is most similar morphologically to some forms of *C. mutabilis*, which have sparsely branched, sometimes quite slender pseudopodetia with acute-angled axils. These forms, however, differ chemically in containing fumarprotocetraric acid; they also tend to be much shorter.

Fertile pseudopodetia are not uncommon in this species and, furthermore, most apothecia studied were well-formed and with abundant, well-developed asci containing spores. This is in sharp contrast to material studied of *C. inflata* and *C. mutabilis* where most apothecia seem to lack fertile asci. The fertile pseudopodetia are not unlike those of *C. aggregata* although they are more loosely branched and not significantly more robust than the sterile ones. Tiered, proliferating apothecia are uncommon in *C. dumicola*, in contrast to other species of this complex. The abundant occurrence of pycnidia and apothecia together on the same supporting branchlet appears to be unusual; in other species of the *C. aggregata* group, the development of pycnidia is confined mainly to sterile pseudopodetia or to particular branchlets (usually the lower ones) of the fertile pseudopodetia.

*Distribution and ecology:* *Cladonia dumicola* is endemic to Tasmania where it is confined to western and south-western regions (Fig. 5B). Although typically associated with other species of *Cladonia*, viz. *C. aggregata*, *C. inflata*, *C. retipora* and *C. sullivanii*, it appears to have a narrower ecological range than these widespread relatives. It has been recorded mostly from scrubby copses in buttongrass moorland dominated by *Leptospermum*, *Melaleuca* and *Agastachys*, hence the specific epithet 'dumicola', meaning 'growing in shrubby thickets'. It is also frequent in high altitude cool temperate rainforest of the thamnic and implicate type (nomenclature after Jarman *et al.* 1994) where it grows in well-lit sites on the forest floor, associated mainly with bryophytes.

*Specimens examined:* AUSTRALIA, TASMANIA: Algonian Mountain, 42°24'S, 146°03'E, 950 m a.s.l., G. Kantvilas 64/90, 7 Mar. 1990 (HO); Eastern Arthur Range, 43°14'S, 146°26'E, 780 m a.s.l., G. Kantvilas 119/91, 25 Mar. 1991 (HO); north of Precipitous Bluff, 43°25.5'S, 146°36.5'E, 730 m a.s.l., G. Kantvilas 116/90, 14 Mar. 1990 (HO); Weindorfers Forest, 41°38'S, 145°56'E, 900 m a.s.l., G. Kantvilas, B. Führer, S.J. Jarman 13/92, 25 Jan. 1992 (HO); King William Saddle, 42°13'S, 146°06'E, G. Kantvilas s.n., 27 Sep. 1986 (HO); Dove Lake, 41°40'S, 145°58'E, 940 m a.s.l., G. Kantvilas s.n., 3 June 1986 (HO); Elliott Range, 42°28'S, 145°43'E, 880 m a.s.l. G. Kantvilas s.n., 12 Jan. 1985 (HO); c. 26 km SSE of Queenstown, 42°18'S, 145°37'E, 280 m a.s.l., G.C. Bratt 71/981, 14 June 1971 (HO); 1.5 km SE of McPartlan Pass, 42°52'S, 146°12'E, 330 m a.s.l., G. Kantvilas 196/95, 5 Dec. 1995 (HO); Crotty, 42°12'S, 145°38'E, 200 m a.s.l., G.C. Bratt & M.H. Bratt 72/113, 1 Apr. 1972 (HO); Lake Judd, 42°59'S, 146°25'E, 640 m a.s.l., G.C. Bratt 73/908, 28 July 1973 (HO); Gordon Road, 42°47'S, 146°24'E, 480 m a.s.l., G. Kantvilas 80/96, 10 Nov. 1996 (HO); Lake Sydney, 43°17'S, 146°36'E, 680 m a.s.l., G. Kantvilas 64/98, 14 Mar. 1998 (HO).

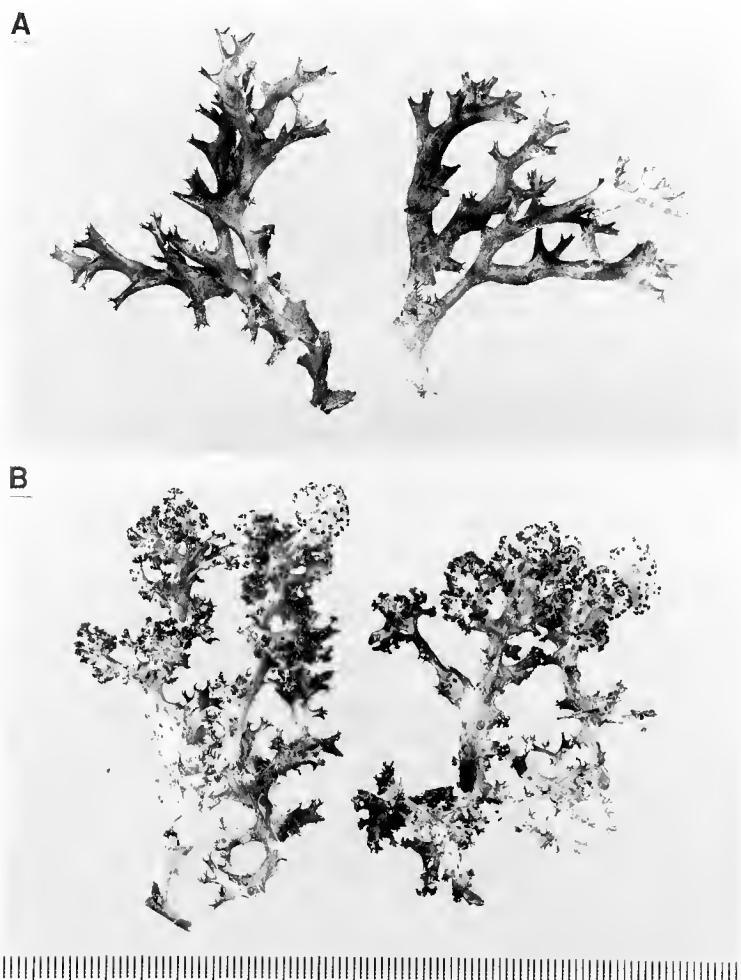
**4. *Cladonia inflata* (F. Wilson) D.J. Galloway, *Nova Hedwigia* 28: 476 (1977). *Cladonia aggregata* var. *inflata* F. Wilson, *Proc. R. Soc. Tasm.* (1892): 153 (1893). *Type:* Tasmania, Maria Island, R.A. Bastow (lectotype *fide* Galloway 1977, NSW).**

*Sterile pseudopodetia* decumbent, forming densely interwoven, spreading clumps or mats, usually decaying at the base, to 50 mm long, ± evenly inflated-cylindrical, 1–4 mm wide, repeatedly dichotomously branched, tapering rather abruptly at the apices; surface ± glossy, smooth to faintly undulate, wrinkled or dimpled, pale yellow-brown, olive-brown to reddish brown, pale greenish when in deep shade; axils neither perforate nor constricted, forming angles of 35–90°; perforations round to oval, 0.2–2 mm wide, usually very few to absent, especially on the 'upper' surface, sometimes numerous; medullary cavity white tomentose throughout. *Fertile pseudopodetia* uncommon, decumbent, ± identical to sterile pseudopodetia, except sometimes rather more racemously branched and perforate near the apices. *Apothecia* apical on short branchlets,

mostly solitary or in groups of 2–3, to 0.2 mm wide, usually proliferating in 2–3 compressed tiers, typically sterile and comprised internally of erect, stout, sterile hyphae and very deformed, weakly amyloid or non amyloid asci. *Ascospores* very rare, ellipsoid, 8–10 × 3–4 µm. *Pycnidia* common, occurring singly or in pairs at the apices of the sterile and fertile pseudopodetia, occasionally also laminal. *Conidia* filiform, falcate, with blunt apices, 5–6 × 0.6–0.8 µm. (Figs 1 E, 7)

*Chemistry:* fumarprotocetraric acid, succinprotocetraric acid (±), protocetraric acid (±), physodalic acid (±); medulla K-, KC-, C-, Pd+ red, UV-.

*Remarks:* The above description pertains to what we define here as *Cladonia inflata* in the strict sense. This distinctive taxon is characterised by its decumbent, clump or mat-forming habit, and by its pseudopodetia which are broad and rather regularly inflated and cylindrical, and repeatedly dichotomously branched, usually at rather wide angles (up to 90°). Also very distinctive are the apices of the pseudopodetia which taper very abruptly before terminating in pycnidia, and hence appear rather truncate; in contrast, the



**Fig. 7.** *Cladonia inflata* (Kantvilas 73/98). **A** sterile pseudopodetia; **B** fertile pseudopodetia. Scale in mm.

pseudopodetia of the other species of the group taper gradually to a point or are blunt and rounded. In typical specimens, perforations are very few and often none at all are evident when the thallus is viewed from above. Fertile pseudopodetia are uncommon, but are  $\pm$  identical with the sterile pseudopodetia in form and size. Despite studying numerous, seemingly well-developed apothecia, fertile asci or spores appear to be rare. The 'hymenium' instead contains mostly numerous, robust, erect sterile hyphae and occasional deformed or immature asci which do not display the expected amyloid reactions.

The type specimen of *C. inflata* is rather fragmented and small, but nevertheless clearly displays the characteristic morphology of this species. It contains fumarprotocetraric acid, succinprotocetraric acid (trace), protocetraric acid (trace) and physodalic acid (minor). Its provenance (Maria Island, eastern Tasmania) is also well within the known distribution of *C. inflata* as defined by us.

In our view, *C. inflata* is easily recognised in the field, especially when well-developed. Perhaps the most similar species is *C. mutabilis*, and indeed, the decision to segregate the latter as a separate taxon was taken only after a very extensive study of a wide range of material, both in the laboratory and the field (see also under *C. mutabilis*, below). *Cladonia mutabilis* differs from *C. inflata* in its erect habit, its sterile pseudopodetia with acute apices and sparse branching, typically at very acute angles, and its robust, mainly corymbose fertile pseudopodetia. The features of the sterile pseudopodetia also distinguish the fumarprotocetraric acid-containing races of *C. aggregata* from *C. inflata*. A minor chemical observation is that in *C. inflata*, fumarprotocetraric acid usually occurs together with other related compounds, whereas in *C. aggregata* and *C. mutabilis*, this substance tends to occur alone.

*Cladonia inflata* differs from *C. mouieri* and *C. deformis* by its unconstricted axils and regularly inflated pseudopodetia, as well as chemically. At high altitudes, it may be confused with a very robust, inflated, sparsely branched form of *C. aggregata*. However, such individuals are chemically distinct, in that they contain barbatic acid (medulla Pd-). They also differ morphologically in forming sparse  $\pm$  erect clumps to 80 mm tall, and usually comprise a main axis or axes with rather long internodes (10–15 mm), bearing short laterals with deflexed apices and rather broadly angled (often  $>90^\circ$ ) axils.

*Distribution and ecology:* *Cladonia inflata* s. str. is a widely distributed species, occurring in Tasmania, south-eastern Australia and New Zealand. Unlike most of its segregates, it also displays the broadest ecological amplitude, ranging from lowland to alpine altitudes, and from the very high rainfall ( $>3000$  mm per annum) *Gymnoschoenus*-dominated blanket bogs of south-western Tasmania to relatively dry heathlands and sclerophyll woodlands (Fig. 5C). It typically grows on peaty or sandy soil in association with other species of *Cladonia*, *Cladonia sphaerophylla* and *Sipula decumbens*. Further details of its distribution are given for New Zealand by Galloway (1977) and for Tasmania by Kantvilas and Elix (1987).

*Selected specimens examined* (total = 35): AUSTRALIA, NEW SOUTH WALES: Morton National Park, 35° 07' S, 150° 08' E, 760 m a.s.l., J.A. Elix 19281 & J. Johnston, 26 June 1985 (HO, distributed as *Lichenes Australasici* Exsiccati 102). TASMANIA: Mt Cameron, 40° 59' S, 147° 57' E, c. 500 m a.s.l., G. Kantvilas 81/93, 13 Aug. 1993 (HO); Mt Wellington, 42° 55' S, 147° 14' E, A.V. Ratkowsky L71, 12 Nov. 1980 (BM, HO); summit of Moores Pimple, 41° 52' S, 145° 29' E, L. Rodway s.n., Nov. 1893 (HO); plateau south of Mt Darwin, 42° 17' S, 145° 35' E, 680 m a.s.l., G.C. Bratt & J.A. Cashin 71/936, 12 June 1971 (HO); Rocky Cape, 40° 51' S, 145° 30' E, 270 m a.s.l., G. Kantvilas s.n., 5 June 1986 (HO); Mt William, 40° 55' S, 148° 11' E, 120 m a.s.l., A. Moscal 2541, 8 Sep. 1983 (HO); Flynn's Tarn, 41° 41' S, 145° 58' E, 960 m a.s.l., G. Kantvilas 93/95, 17 Sep. 1995 (HO); Mt Norold, 43° 15' S, 146° 15' E, 950 m a.s.l., G. Kantvilas 33/94, 24 Feb. 1994 (HO); Red Knoll, 43° 02' S, 146° 17' E, 440 m a.s.l., G. Kantvilas 95/95, 21 Sep. 1995 (HO); Lawson Range, 42° 57' S, 145° 41' E, 520 m a.s.l., A. Moscal 11911, 24 Jan. 1986 (HO); Bass Strait, Cape Barren Island, c. 250 m a.s.l., J.S. Whinray 1251, 20 Apr. 1980 (HO, MEL).

5. *Cladina moniliformis* Kantvilas & Elix, *Mycotaxon* 29: 199 (1987). *Type*: Australia, Tasmania, north of Sentinel Range, c. 4 km SE of Mt Cullen, on wet peaty soil in buttongrass moorland, 320 m a.s.l., 2 Nov. 1986, G. Kantvilas & J. Jarman 169/86 (holotype HO; isotypes BM, CANB, MEL 2051773).

A full description of this species is given by Kantvilas and Elix (1987) and is not repeated here. *Cladina moniliformis* is characterised by a dispersed to decumbent habit, grossly inflated sterile pseudopodetia with markedly constricted axils and irregularly bulbous or cylindrical segments to 12 mm wide, and by its rather slender, racemose fertile pseudopodetia. Since our earlier work (Kantvilas and Elix 1987), we have also revised the observed dimensions of the spores and conidia: spores are 9–12 × 3–4.5 µm, (marginally larger than those of the other species in the group) whereas the conidia are 6–10 × 0.6–1.5 µm (also marginally longer) (Figs 1B, 1G). *Cladina moniliformis* is chemically unique in the genus and contains homosekikaic acid (medulla K-, KC-, C-, UV-, Pd-) (see also Table 1).

When well developed, *C. moniliformis* is one of the easiest members of this species complex to recognise in the field. The most superficially similar species is *C. deformis* and, where the two taxa occur together, considerable care must be taken in distinguishing them. Key field characters for *C. moniliformis* are the dispersed and decumbent, rather than clumped and erect habit, the matt and scabrid rather than glossy surface of older thalli, the yellowish to blackish rather than somewhat reddish brown colour of the cortex, and the generally bulbous rather than elongate pseudopodetial segments (Fig. 8).

The distribution and ecology of the species is discussed by Kantvilas and Elix (1987). Since that work, considerable additional field work in Tasmania and elsewhere has confirmed that this species is very much restricted to the south-west of Tasmania, where it is found mostly on gravelly, peaty soils over infertile, pre-Carboniferous rock types, such as Precambrian metamorphosed sediments and Ordovician conglomerate (Fig. 5D). Only at alpine altitudes, does it occur on other rock types such as Triassic sandstone or Jurassic dolerite.

*Selected specimens examined* (total = 58): AUSTRALIA, TASMANIA: Scotts Peak Road near airstrip, 43°02'S, 146°19'E, 340 m a.s.l., G. Kantvilas & J. Jarman 86/91, 13 Mar. 1991 (HO, distributed as *Lichenes Australasici Exsiccati No. 227*); Humboldt Divide, 42°43'S, 146°27'E, G.



Fig. 8. *Cladina moniliformis* (Kantvilas 74/98); fertile pseudopodetia at left. Scale in mm.

*Kantvilas* s.n., 28 July 1986 (HO); Mt Norold, 43°15'S, 146°15'E, 950 m a.s.l., *G. Kantvilas* 35/94, 24 Feb. 1994 (HO); The Knob, 42°44'S, 145°58'E, 440 m a.s.l., *G. Kantvilas* 189/95, 5 Dec. 1995 (HO); 1.5 km SE of McPartlan Pass, 42°52'S, 146°12'E, 330 m a.s.l., *G. Kantvilas* 194/95, 5 Dec. 1995 (HO); Gordon River Road, 1 km E of Boyd Lookout, 42°49'S, 146°22'E, 560 m a.s.l., *G. Kantvilas* 110/95, 21 Sep. 1995 (HO).

### 6. *Cladonia mutabilis* Kantvilas & Elix sp. nov.

Species *Cladiae inflatae* affinis sed habitu erecto, pseudopodetiis sterilibus apicibus acutis, pseudopodetiis fertilibus robustis excelsisque, sporis parvioribus, et modo acidum fumarprotocetraricum continentis praeccipue divergens.

*Type*: Australia, Tasmania, The Knob, 42°44'S, 145°58'E, on soil at disturbed roadside edge in buttongrass moorland, 440 m a.s.l., 5 Dec. 1995, *G. Kantvilas* 187/95 (holotype HO; isotype CANB).

*Sterile pseudopodetia* erect, forming clumps or spreading swards, slender, varying from evenly tapered and not inflated, to quite grossly inflated, dimpled and puckered, 20–60 mm tall, 0.4–5 mm wide, dichotomously or trichotomously branched up to 6 times, tapering to acute or sometimes awl-like apices containing pycnidia; surface smooth and mostly glossy, olive-brown to brown, olive-greenish in shade; axils closed, not constricted, forming angles of 20–45°; perforations abundant, 0.1–2 mm wide, ellipsoid or rather slit-like in very slender pseudopodetia, usually in rows to one side of the pseudopodetia; medullary cavity farinose, consistently whitish. *Fertile pseudopodetia* typically more robust and taller than the sterile pseudopodetia, usually discrete, often rather bulbously inflated to 7 mm at the base, then tapering to 2–4 mm wide, typically corymbose and highly perforate in the upper part. *Apothecia* apical, black, 0.1–0.25 mm wide when well-developed, proliferating with up to 6 tiers, clustered in groups of up to 9. Ascospores ellipsoid, 8–10 × 3–4.5 µm (rather rare). *Pycnidia* common, usually at the apices of sterile pseudopodetia. *Couidia* filiform, usually curved, (5–)6–8(–10) × 0.8–1.5 µm. (Fig. 9)

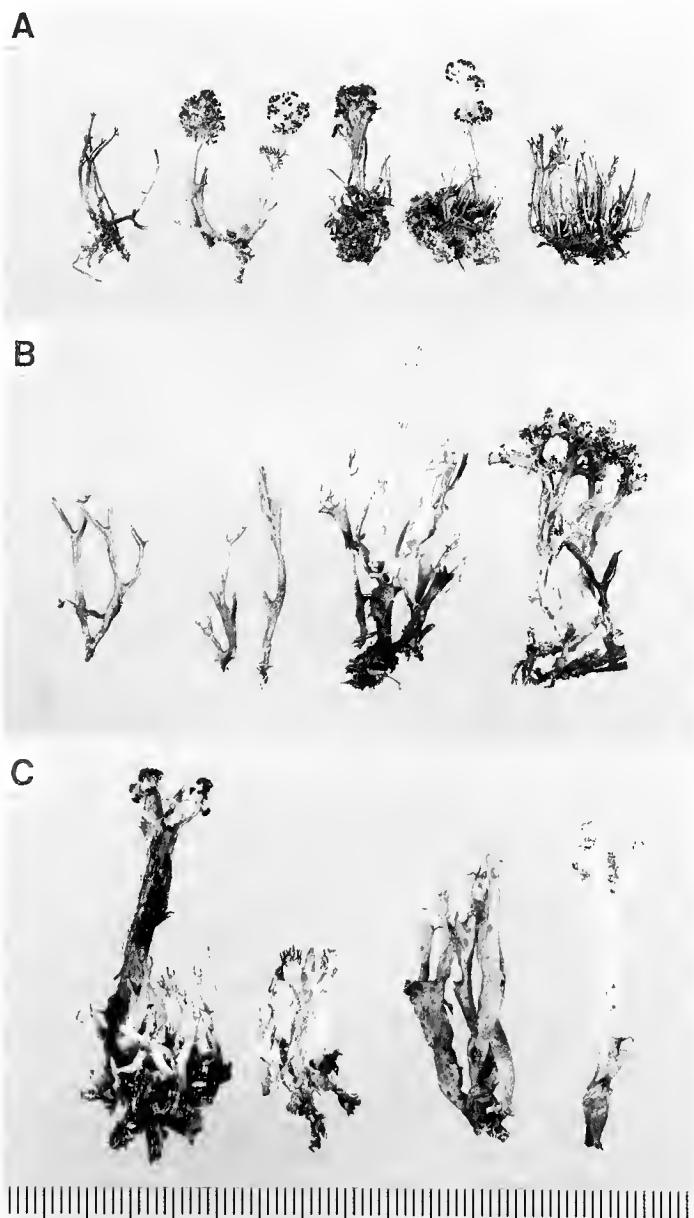
*Chemistry*: fumarprotocetraric acid; medulla K-, C-, KC-, Pd+ red. UV-.

*Remarks*: As suggested by the specific epithet, *C. mutabilis* is morphologically extremely variable, at least with respect to the size of the pseudopodetia. Individuals range from being very slender and filiform, rather like *Cladonia gracilis* ssp. *teucrium* Ahti, to being distinctly inflated. The slender forms are perhaps most similar to *Cladonia aggregata*, and are best distinguished from that species by their discrete branches which diverge at very acute angles. In contrast, the branches of slender, uninflated forms of *C. aggregata* are tangled and diverge at much broader (often obtuse) angles. Most *C. aggregata* also differ chemically in containing barbatic acid, although populations of this species which contain fumarprotocetraric acid may be sympatric with *C. mutabilis*.

The more robust inflated forms of *C. mutabilis* are most similar to *C. deformis* in that both taxa share a rather dimpled, puckered appearance. In such cases, distinguishing these species, especially sterile material, requires considerable care. Key characters include the constricted and at times perforate axils of *C. deformis*, its essentially 'segmented' form, even along a single branch, its blunt apices, and its generally reddish brown hue. The two taxa also differ chemically, but the presence of stictic acid in *C. deformis* should not be sought by spot tests alone. The branching pattern of *C. mutabilis*, which occasionally includes trichotomies or 'compressed' dichotomies is a further general helpful character in distinguishing this species in the field. These robust inflated forms may also be similar to *C. inflata*, a species with generally the same chemical composition. However, *C. inflata* differs by its decumbent habit and rather truncate pseudopodetia.

The distinctiveness of *C. mutabilis* is best seen in fertile material, which has the

'typical' morphology of *C. aggregata* with markedly stouter fertile pseudopodetia carried above the sterile parts of the thallus. In *C. mutabilis*, these may be particularly robust and bulbous at the base, taper centrally and then expand in the upper part to the typical branched, perforate form. In contrast, in the other species of the complex, the fertile pseudopodetia are either of similar dimensions to the sterile ones (as in *C. inflata* and



**Fig. 9.** Morphological variation in *Claudia mutabilis*. **A** Kantvilas 75/98; **B** from left: Kantvilas 1977/95, Kantvilas s.n. (HO 114098), Kantvilas 75/98 (two clumps); **C** part of type (left) and Kantvilas s.n. (HO 114097) (right). Note the relatively robust fertile pseudopodetia. Scale in mm.

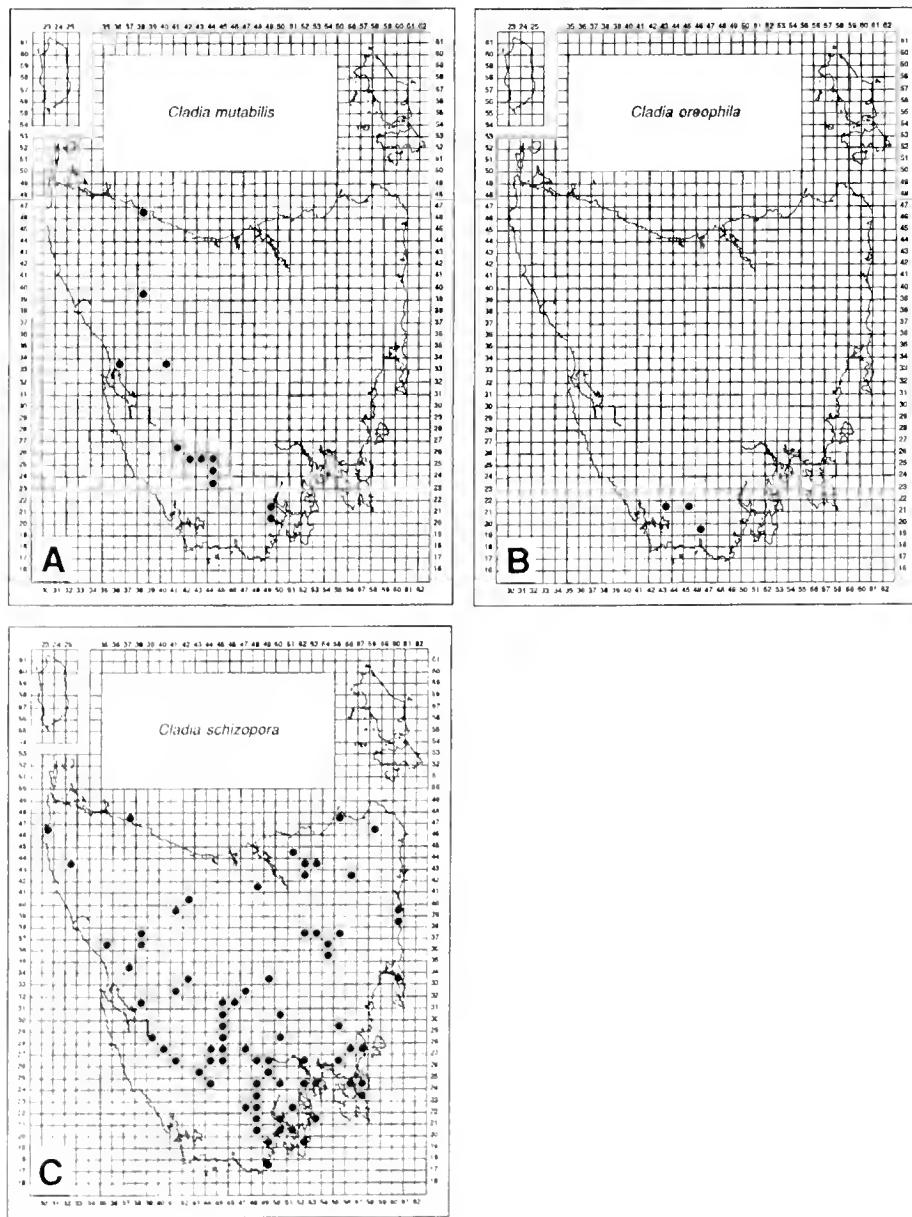


Fig. 10. Distribution of species of *Cladonia* in Tasmania. A *C. mutabilis*; B *C. oreophila*; C *C. schizophora*.

*C. dumicola*) or are more slender (as in *C. deformis* and *C. moniliformis*). Furthermore, in *C. mutabilis* they are mostly corymbose, whereas in *C. aggregata*, *C. dumicola* and *C. moniliformis* they are racemose. Despite the abundance of well-formed apothecia in several specimens, very few asci with mature spores could be observed.

The species consistently contains only fumarprotocetraric acid, without any accompanying related substances. Only *C. oreophila* invariably shares this feature; *C. aggregata* often does, whereas *C. inflata* mostly contains additional related substances.

**Distribution and ecology:** *Cladonia mutabilis* is endemic to Tasmania and, like most of its relatives, occurs mainly in the high rainfall peatlands of western Tasmania (Fig. 10A). It appears to be a lowland species (all collections are from below 650 m altitude), and also favours more sheltered, better drained conditions than do, for example, *C. moniliformis* or *C. deformis*. Thus the best developed thalli are found on rather deep, fibrous peaty soil at the scrubby edges of buttongrass moorland, on peat banks along road edges, and even in forest vegetation. It typically grows in association with *Cladonia southlandica*, *Siphula decumbens* and other species of *Cladonia*, such as *C. inflata*, *C. retipora*, *C. sullivanii* and *C. aggregata*.

**Specimens examined:** AUSTRALIA, TASMANIA: Hermit Valley, 42°51'S, 146°08'E, 320 m a.s.l., G. Kantvilas 193/95, 5 Dec. 1995 (HO); same locality, 360 m a.s.l., G. Kantvilas 180/80, 17 May 1980 (HO); Queenstown-Strahan highway, 42°09'S, 145°25'E, 270 m a.s.l., G. Kantvilas s.n., 25 May 1986 (HO); Redan Hill, 42°08'S, 145°53'E, G. Kantvilas s.n., 27 Sep. 1986 (HO); foot of Sentinel Range, 42°52'S, 146°13'E, 360 m a.s.l., G. Kantvilas 197/95, 5 Dec. 1995 (HO); The Knob, 42°44'S, 145°58'E, 440 m a.s.l., G. Kantvilas 190/95, 5 Dec. 1995 (HO); Scotts Peak Road, c. 2 km N of Celtic Hill, 42°55'S, 146°22'E, 280 m a.s.l., G. Kantvilas 98/95, 21 Sep. 1995 (HO); Scotts Peak Road near the airstrip, 43°02'S, 146°19'E, 340 m a.s.l., G. Kantvilas 108/95, 21 Sep. 1995 (HO); Red Knoll, 43°02'S, 146°17'E, 440 m a.s.l., G. Kantvilas 96/95, 21 Sep. 1995 (HO); Frodshams Pass, 42°49'S, 146°23'E, G. Kantvilas s.n., 28 Aug. 1986 (HO); Ti Tree Hill, c. 6 km from Geeveston, 43°14'S, 146°55'E, G.C. Bratt & J.A. Cashin 2252, 15 May 1965 (HO); south of Que River, 41°45'S, 145°40'E, 650 m a.s.l., G. Kantvilas s.n., 22 May 1986 (HO); Raminea Plains, 43°18'S, 146°54'E, G. Kantvilas s.n., 18 Feb. 1986 (HO); same locality, 80 m a.s.l., G. Kantvilas 584/84, 30 Mar. 1984 (HO); Sisters Beach, 10 m a.s.l., J.A. Elix 23810, 11 Jan. 1990 (CANB).

## 7. *Cladonia oreophila* Kantvilas & Elix sp. nov.

Species *Cladiae mutabili* affinis et item pseudopodetia sparsim acutangulata ramosa habens et acidum fumarprotocetraricum continens, sed differt essentialiter pseudopodetii scabridis, verrucosis vel areolatis, foraminibus absentibus vel rarissimis et apicibus decrescentibus sed aliquantum obtusis.

**Type:** Australia, Tasmania, 4 km north of Precipitous Bluff, 43°25'S, 146°36'E, on peaty soil in buttongrass moorland, 730 m a.s.l., 14 Feb. 1990, G. Kantvilas 104/90 (holotype HO; isotype GZU).

**Sterile pseudopodetia** ± erect, forming loosely, tangled swards or clumps, decaying at the base, 35–60 mm tall, (1–)1.5–5 mm wide, simple or sparsely ± dichotomously branched, unevenly cylindrical, rather abruptly tapered to a blunt point, never awl-shaped; surface mottled pale grey in the lower part, brownish towards the apices, blackened at the base, scabrid to verrucose to bullate, usually distinctly areolate, with the areoles contiguous or dispersed and exposing a brown or blackened medulla; axils acute, forming an angle of 20–40°, perforate, not constricted; perforations absent to very rare, rounded and 0.4–0.8 mm wide or, more commonly, forming irregular fissures to 5 mm long and c. 0.3 mm wide; medullary cavity whitish to blackened, smooth to farinose. **Fertile pseudopodetia** not known. **Pycnidia** sparse to abundant, immersed in blunt, lobule-like thalline projections to 0.4 mm long and 0.3 mm wide, black to dark brown, rather glossy, apical in groups of 2–4 or, more commonly, scattered along the length of the pseudopodetium. **Conidia** not found. (Fig. 11)

**Chemistry:** fumarprotocetraric acid; medulla K-, c-, Pd+ red, UV-, KC-.

**Remarks:** The rather inflated pseudopodetia with unconstricted, acute-angled axils, and the presence of fumarprotocetraric acid alone, ally this species most closely to *Cladonia mutabilis*. Nevertheless, *C. oreophila* is a very distinctive lichen, easily recognised in the field. The scabrid to areolate surface of its pseudopodetia is unique: the areoles are irregular to ± stellate, and may be flat and contiguous to coalescing, or rather convex to bullate and dispersed over a blackened, exposed medulla. In sharp contrast, all other



Fig. 11. *Cladonia oreophila* (part of type). Scale in mm.

species of the *C. aggregata*-*C. inflata* complex have a continuous to rather glossy cortex, even when growing in very exposed, wind-abraded habitats.

The near absence of perforations in *C. oreophila*, apart from in the axils, is also distinctive, and hence the species may sometimes resemble some species of *Cladonia* which have a similarly areolate-seabrid cortex. Perforations are also absent or almost so in *C. inflata*, but this species has a decumbent habit and some perforations are usually present on the underside. The rather blunt apices of the pseudopodetia of *C. oreophila* are similarly diagnostic, given that most related species of *Cladonia*, excluding the grossly inflated-constricted species, *C. deformis* and *C. moniliformis*, have acute or awl-shaped apices containing pycnidia. When seen in well-developed colonies in the field, *C. oreophila* gives the impression of brown, crowded, finger-like lobes, protruding through a mat of graminoid monocotyledons, a little like the Northern Hemisphere alpine lichen genus *Dactylina*.

Apothecia and ascospores have not been found in *C. oreophila*. Nor have conidia been observed, despite the abundance of seemingly well-developed pycnidia in at least one specimen, and the pycnidia sectioned contained at most only tightly coiled hyphae.

*Distribution and ecology:* *Cladonia oreophila* is a rare species known at present from only three locations in the remote mountain ranges of south-western Tasmania (Fig. 10B). Unlike the other species of *Cladonia*, which have a rather broad ecological and altitudinal range, this new species appears to be exclusively alpine, hence the specific epithet 'oreophila' meaning 'mountain loving'. It occurs in exposed alpine heathlands and moorlands, typically in relatively open patches of low sedgeland-heathland dominated by *Carpha curvata*, *Dracophyllum milliganii*, *Empodisma minus* and *Oreobolus oligocephalus*. Common lichens with which *C. oreophila* is associated include *Cladonia moniliformis*, *C. inflata*, *C. retipora* and *Siphula decumbens*.

*Specimens examined:* AUSTRALIA, TASMANIA: Mt Norold, 43°15'S, 146°15'E, 950 m a.s.l., G. Kantvilas 29/94, 24 Feb. 1994 (HO); Eastern Arthur Range, c. 1 km south of East Portal, 43°14'S, 146°26'E, 930 m a.s.l., G. Kantvilas 102/91, 25 Mar. 1991 (HO).

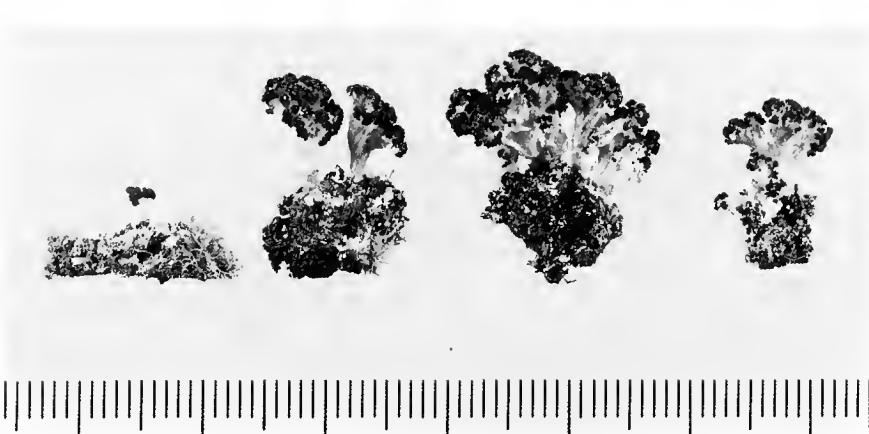


Fig. 12. *Cladonia schizophora* (Kantvilas 8/98). Scale in mm.

8. *Cladonia schizophora* (Nyl.) Nyl. in Hue, *Rev. Bot.* 6: 161 (1888). *Cladonia schizophora* Nyl., *Syn., Meth. Lich.*: 217 (1860). *Type*: Tasmania, supra trunco putridos, C. Stuart (holotype H-NYL, n.v.).

*Cladonia schizophora* is the only sorediate species in the genus. It is further characterised by having very short, corymbose fertile pseudopodetia, mostly <15 mm tall but occasionally c. 20 mm tall in very moist, shaded habitats (Fig. 12). Soredia develop internally within the fertile pseudopodetia and at the apices of the sterile pseudopodetia, which may become reduced to a sorediate, subsquamulose mat. Some sterile specimens may be entirely sorediate and resemble a coarse *Lepraria*. This species contains fumar-protocetraric acid and traces of protocetraric acid; medulla Pd+ red, K-, KC-, C-, UV-. Further descriptions are provided by Galloway (1985) and Filson (1981, 1992).

*Distribution and ecology*: This species is known from southern Australia, New Zealand and southern Chile. In Tasmania it is widespread, mainly in lowland areas of low to medium rainfall, growing on bark, charcoal and lignum, or rarely on peaty soil (Fig. 10C). By far the most common host is *Eucalyptus*, where *C. schizophora* grows in association with *C. aggregata*, *Cladonia rigida* and *Neophyllum melacarpa*. In drier areas, additional associated lichens include *Thysanothecium scutellatum*, *Hypocenomyce australis* and *H. foveata*.

*Selected specimens examined* (total = 99): AUSTRALIA, TASMANIA: Moogara, 460 m a.s.l., G. Kantvilas 30/80, 10 Mar. 1980 (HO, BM); Anthony Road, 41°50'S, 145°38'E, G. Kantvilas 241/91, 10 May 1991 (HO); O'Grady's Gully, Mt Wellington, 42°55'S, 147°16'E, A.V. Ratkowsky L81, 16 Mar. 1981 (BM, HO); Franklin River Plains, 42°13'S, 146°02'E, 390 m a.s.l., G.C. Bratt & M.H. Bratt, 2 Jan. 1966 (HO); Comstock Mine, 41°55'S, 145°17'E, G.C. Bratt 4040, 30 Mar. 1969 (HO); Mueller Road, 42°49'S, 146°28'E, 550 m a.s.l., G. Kantvilas 8/98, 21 Feb. 1998 (HO).

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## A New Peppermint for Victoria

K. Rule

Department of Botany, La Trobe University, Bundoora, Victoria

### Abstract

*Eucalyptus molyneuxii* K. Rule, a rare peppermint occurring in Victoria's Little Desert, whose features include narrow-lanceolate, falcate, sub-lustrous, green juvenile leaves, and comparatively small, thick-walled fruits, is described. Its distribution, ecology, affinities and conservation status are discussed.

### Introduction

“Shining Peppermint” and “Shiny-leaved Peppermint” are names that have been loosely applied to a number of peppermint eucalypts with varying degrees of coriaceous, lustrous adult leaves. Tasmanian populations exhibiting these features were described firstly as *E. nitida* Hook. (1856) and then as *E. simmondsii* Maiden (1922). Later, Willis (1970) considered these as conspecific and Willis again (1973) regarded Victorian peppermints with similar features as a part of *E. nitida*. However, studies by Marginson & Ladiges (1982) and Marginson, Ladiges & Brooker (1983) justified the segregation of the mainland populations of Wilsons Promontory, the Gippsland Lakes region, south-western Victoria and adjacent areas of South Australia and the Grampians as *E. willisii*. In both studies fundamental differences in juvenile morphology were identified. Newnham, Ladiges & Whiffen (1986), in a follow-up study, described the Grampians populations as *E. willisii* subsp. *falciformis*. Their decision was supported by the new subspecies being separable in a wide range of characters, most notably by its distinctly falcate juvenile leaves. They also found that the form occurring in south-western Victoria and adjacent areas of South Australia exhibited adult features close to the new subspecies but retained it as a part of *E. willisii* subsp. *willisii* on the grounds of similarities in juvenile morphology.

More recently, however, Mr David Rankin of La Trobe University, in an as yet unpublished wider study of the peppermints, found marked regional differences within *E. willisii* to the extent that a further taxonomic revision is needed (pers. comm.). For example, the populations of the Gippsland Lakes region (here referred to as the “Gippsland Lakes Form”) have been found to represent an undescribed taxon. As well, the populations occurring in subcoastal and coastal areas of south-western Victoria and adjacent areas of South Australia, together with *E. willisii* subsp. *falciformis*, have been found to constitute a western complex of variable shining peppermints.

Further, the discovery in 1966 of the species treated here in the most unlikely location of Victoria's Little Desert National Park has again increased the number of Victorian endemic shining peppermints. The features of this new species include narrow-lanceolate, falcate, sublustrous, green juvenile leaves and comparatively small, thick-walled fruits. Comparative seedling trials and field studies have demonstrated its morphology as markedly distinctive and it is thus described as a new species.

### Taxonomy

#### *Eucalyptus molyneuxii* K. Rule *sp. nov.*

*E. willisii* Ladiges, Humphries & Brooker affinis; a subsp. *willisii* ramulis non-pendulis, foliis juvenalibus anguste lanceolatis falcatis nitentibus viridibus non-

amplexicaulibus, foliis adultis nitentibus viridibus differt; a subsp. *falciformis* Newnham, Ladiges & Whiffen ramulis non-pendulis, foliis juvenalibus et adultis minoribus angustioribus nitentibus viridibus, et alabastris et fructibus minoribus differt.

*Type:* Victoria, Wimmera, the 15 km post along the Medonald Highway, Little Desert N P, 36°35'S, 141°29'E, 15 vi 1997, K. Rule 9795 and P. Hawker (holotype MEL 2052701, isotypes AD, CANB).

*Mallee* or small *trees* to 5 m tall; branchlets semi-rigid. Bark peppermint-like, to various heights, often loosely attached, grey, thin; upper bark smooth, yellowish. *Seedling stems* verrucose. Seedling leaves decussate, narrow-elliptical, lustrous, dark green above, discolored. *Juvenile leaves* decussate for a few pairs then irregularly arranged, opposite for at least 15 pairs, subsessile by 12 pairs, non-amplexicaul, linear-lanceolate or narrow-lanceolate, tapered to a fine point, falcate and vertically oriented by 10–15 pairs, sublustrous, green, slightly discolored, 8–13 cm long, 0.8–1.5 cm wide. *Intermediate leaves* opposite, subopposite or alternate, lanceolate, falcate, broader than juvenile leaves, sub-lustrous, green or blue-green. *Adult leaves* alternate, petiolate, the blade lanceolate, 6–11 cm long, 1–1.6 cm wide, lustrous, green, concolorous, markedly coriaceous (0.38–0.51 mm thick), acuminate, uncinate, glandular; petioles thick, flattened, 0.5–1 cm long; venation acute (sub-parallel), visible but not conspicuous; lateral veins angled at 15–25 degrees to midvein; intramarginal 2–3 mm from margin with a faint secondary intramarginal vein approximately 1 mm from margin; areoles large, containing relatively large, scattered island glands. *Inflorescences* axillary, simple, 11–15-flowered, tightly clustered; peduncles thick, angled, 5–8 mm long. *Floral buds* ovoid-clavate, subsessile or shortly pedicellate, 5–7 mm long, unscarred, 3–4 mm wide; operculum obtuse-conical; locules 3 or 4; ovular rows 2; filaments white; stamens inflexed, all fertile; anthers versatile, reniform, opening by oblique, confluent slits. Flowering in Autumn. *Fruit* subsessile, less often sessile, cupular or obconical, 4–5 mm long, 5–6 mm wide; pedicels 0–2 mm long; disc at rim level, approx. 1.5 mm wide; orifice small, 2–3 mm wide; valves 3 or 4. Fertile seeds black-brown, pyramidal; dorsal surface rounded; hilum ventral (See Figure 1).

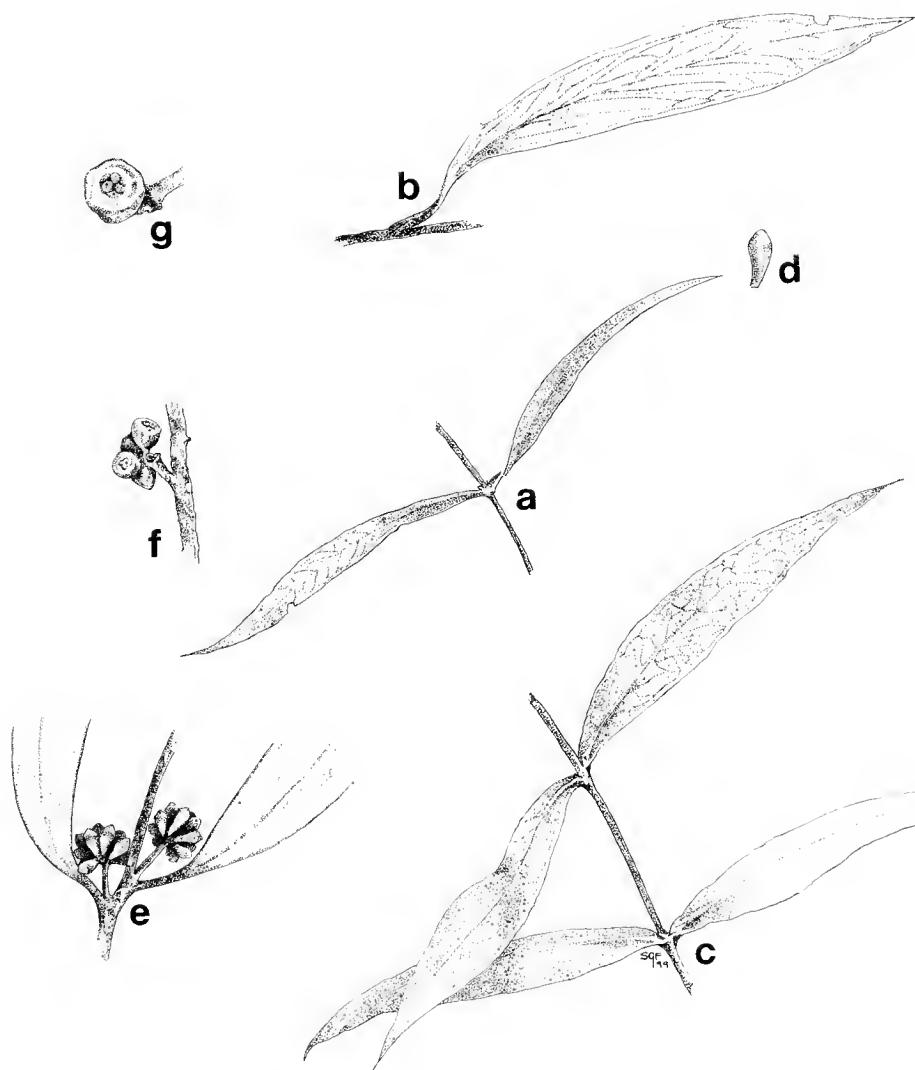
*Additional specimen examined:* VICTORIA: Little Desert, along the Medonald Hwy., approx. 12 km east of the Nhill-Harrow Road, 36°35'S., 141°29' E., 15 vi 1997, K. Rule 9796 and P. Hawker (MEL).

*Distribution and habitat:* *Eucalyptus molyneuxii* is known from only two small populations, both of which occur on deep siliceous sands in the central section of the Little Desert National Park in Western Victoria. The annual rainfall of the region is approximately 500 mm, most of which occurs in winter.

*Etymology:* The epithet honours W. M. (Bill) Molyneux of Dixon's Creek, Victoria, for his contributions to the taxonomy and understanding of several Victorian plant genera, including *Grevillea*, *Callistemon*, *Leptospermum* and *Acacia*, for his contributions of collected specimens of many genera of plants to various Australian herbaria, and for his many years of pioneering work in the cultivation of native plants. Bill was also a member of the environmental action group which campaigned against the opening up of the Little Desert for farming during the late 1960's. Such action led to the establishment of the Little Desert National Park and appears to have saved this species from extinction.

*Associated species:* *Eucalyptus arenacea* Marginson & Ladiges, which is a dominant species throughout the Little Desert, occurs adjacent to but not with the new species. Other species within the vicinity include *E. wiunneensis* K. Rule, *E. sabulosa* K. Rule, *E. leptophylla* F. Muell. ex Miq., *E. iteacassata* Labill. and *E. leucoxylon* F. Muell. subsp. *stephaniae* K. Rule.

*Conservation status:* Both of the known populations of *E. molyneuxii*, each of which consist of about a dozen plants, are secure in the Little Desert National Park. Evidence of charred trunks suggest that the species copes with fire but, nonetheless, its situation is highly vulnerable. In accordance with Briggs & Leigh (1989) a status of 2V is suggested.



**Fig. 1.** Illustration of *Eucalyptus molyneuxii*. **a** juvenile leaves ( $\times 1$ ), **b** adult leaf ( $\times 1.5$ ), **c** intermediate leaves ( $\times 1$ ), **d** bud ( $\times 2.5$ ), **e** inflorescence ( $\times 2$ ), **f** fruit cluster ( $\times 1$ ), **g** fruit ( $\times 3$ )

#### Key to Victorian peppermints

1. Bark hard, compact, occurring on lower trunk; decorticate bark hanging in long ribbons from trunk and major branches; forest trees of East Gippsland (and South-east NSW) or smooth-barked mallees occurring on rocky ridges and slopes in the same region ..... *E. elata*
1. Bark rough, short-fibred (peppermint type), occurring on at least lower trunk.
  2. Mature adult leaves dull, rough-surfaced, thin-textured; fruits thin-walled (disc to 1 mm wide).
    3. Adult leaves green; smallish forest and woodland trees of central Victoria (and the highlands adjacent to Sydney) ..... *E. radiata*

3. Adult leaves greyish.
4. Juvenile leaves linear-lanceolate; adult leaves narrow-lanceolate (0.8–1.5 cm wide); tallish forest trees of north-eastern Victoria (and south-eastern NSW) ..... *E. robertsouii* (syn. *E. radiata* subsp. *robertsouii*)
4. Juvenile leaves broad-lanceolate or ovate; adult leaves lanceolate or broad-lanceolate (1.4–3 cm wide); smallish forest trees of east and central Gippsland (and the south coast of NSW) ..... *E. croajingolensis*
2. Mature adult leaves lustrous or sublustrous, smooth-surfaced, coarse-textured; fruits thick-walled (disc wider than 1 mm).
  5. Juvenile leaves cordate or broad-ovate, to 7 cm wide, usually waxy, sometimes connate; small trees and mallees throughout the Great Dividing Range of Victoria (and NSW) ..... *E. dives*
  5. Juvenile leaves broad-lanceolate or ovate or narrower, to 3 cm wide, never waxy, never connate.
    6. Juvenile leaves green; branchlets not pendulous; fruits sessile or subsessile; small mallees and trees of the Little Desert ..... *E. molyneuxii*
    6. Juvenile leaves greyish; branchlets pendulous; fruits distinctly pedicellate.
      7. Fruits 4–5 mm long, 4–6 mm wide; small trees and mallees of Wilson's Promontory ..... *E. willisii* sens. strict.
      7. Fruits 5–7 mm long, 6–9 mm wide.
        8. Juvenile leaves narrow-lanceolate; adult leaves 0.8–1.4 cm wide .... *E. willisii* (Gippsland Lakes Form)
        8. Juvenile leaves broad-lanceolate or ovate; adult leaves 1.8–3.5 cm wide; small woodland trees and mallees throughout the Grampians and of coastal and subcoastal habitats of south-western Victoria (and Lower South-east S A) ..... *E. willisii* subsp. *falciformis*

## Discussion

*Eucalyptus molyneuxii* exhibits most of the features of *Eucalyptus* Series *Radiatae* Chippendale, which include: Bark being short-fibred (peppermint type); conspicuous verrucae on seedling stems; juvenile leaves that are decussate, opposite, sessile for numerous pairs and rich in oil glands; adult leaves symmetrical with acute lateral veins and numerous scattered island glands within relatively large areoles; inflorescences containing relatively large numbers of clavate-like floral buds; and hemispherical or oboconical fruits with relatively broad, flattened discs approximately at rim level. The thick-walled fruits (in relation to fruit size) place *E. molyneuxii* within Superspecies *Dives* Marginson, Ladiges and Brooker, the so-called shining peppermints. *Eucalyptus molyneuxii* is distinguished from other mainland shining peppermints by the following combination of morphological features: Its small, often mallee habit; thin, often loose peppermint bark; non-pendulous branchlets (a feature possessed by other eucalypts occurring in its semi-arid habitat); appreciably narrow, falcate (by 10–15 pairs), non-amplexicaul, sub-lustrous, green juvenile leaves; relatively small, lustrous, green adult leaves with widely scattered oil glands; 11–15-flowered inflorescences; subsessile or shortly pedicellate buds; and smallish, sessile or subsessile fruits with relatively broad discs and small orifices. Furthermore, its desert-like habitat of deep, well-drained siliceous sands, is atypical of the peppermints at large, which favour cooler, more moist conditions.

*Eucalyptus molyneuxii* is related to *E. willisii* subsp. *falciformis* on the basis of some shared features in both juvenile and adult leaves. In both taxa, the juvenile leaves are always non-amplexicaul and become falcate and vertically-oriented at a relatively early stage compared with others of the group. As well, their adult leaves have widely scattered oil glands and are relatively coriaceous. However, *E. willisii* subsp. *falciformis* differs by

its habit that is pendulous; juvenile leaves that are broader (to 12 cm long, 5 cm wide) and greyish; adult leaves that are larger (to 17 cm long, 3.5 cm wide), usually duller and blue-green; and fruits that are larger (5–7 mm long, 6–8 mm wide) and borne on longer pedicels (4–7 mm long). In western coastal and subcoastal populations, however, juvenile leaves differ from *E. molyneuxii* in not only being broader and duller, but in being amplexicaul in early development.

*Eucalyptus willisii* *sensu strict.*, also regarded as a relative of *E. molyneuxii*, has similar-sized buds and fruits, but differs by a habit that is pendulous; juvenile leaves that are broader (to 3 cm wide), duller, horizontally-oriented and amplexicaul for numerous pairs; adult leaves that are generally larger (to 15 cm long, 2 cm wide), considerably thinner (0.18–0.28 mm), duller and have visibly more crowded oil glands; inflorescences that carry a greater number of buds (15–25); and the fruits usually have longer pedicels (2–4 mm long). The Gippsland Lakes form of *E. willisii* also has some features in common with the new species, particularly its lustrous, green, smallish adult leaves, but differs by its habit that is pendulous; juvenile leaves that are duller and horizontally oriented; adult leaves that are thinner (0.30–0.39 mm) but with a greater density of oil glands; and fruits that are larger (5–6 mm long, 6–9 mm wide) and borne on longer pedicels (3–6 mm long).

*Eucalyptus dives* also differs from *E. molyneuxii* in a wide range of characters. It has a habit that is pendulous; juvenile leaves that are horizontally-oriented, amplexicaul, often waxy, sometimes connate and broader (to 10 cm long, 7 cm wide); adult leaves that are larger (to 15 cm long, 3.5 cm wide) duller and bluish; and fruits that are larger (5–6 mm long, 6–8 mm wide) and borne on longer pedicels (3–5 mm long).

### Acknowledgments

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## The Corticolous Species of the Lichen Genus *Rinodina* (Physciaceae) in Temperate Australia

H. Mayrhofer<sup>1</sup>, G. Kantvilas<sup>2</sup> and K. Ropin<sup>3</sup>

<sup>1</sup>Institut für Botanik, Karl-Franzens-Universität Graz, Holteigasse 6, A-8010 Graz, Austria.

<sup>2</sup>Tasmanian Herbarium, GPO Box 252-04, Hobart, Tasmania 7001, Australia.

<sup>3</sup>Johann-Nestroy-Gasse 9/8, A-8605 Kapfenberg, Austria.

### Abstract

A revision of corticolous and lignicolous species of the genus *Rinodina* (Ach.) Gray (lichenized Ascomycetes, Physciaceae) in temperate Australia is presented. Eight taxa are treated, of which two are described as new: *Rinodina confusa* H. Mayrhofer & Kantvilas and *R. elixii* H. Mayrhofer, Kantvilas & Ropin. The most important characters are outlined briefly and a key to the taxa is provided. Excluded taxa, including *Amandinea insperata* (Nyl.) H. Mayrhofer & Ropin *comb. nov.*, are also discussed. *Rinodina austriensis* Müll. Arg., *R. conradii* Körb. and *R. dolichospora* Malme are lectotypified.

### Introduction

*Rinodina* is a cosmopolitan genus of approximately 200 species (Hawksworth *et al.* 1995) belonging to the large lichen family, Physciaceae. It is characterised by a generally crustose thallus, a *Trebouxia*-like photobiont, mostly lecanorine apothecia, *Lecanora*-type ascii (Rambold *et al.* 1994), brown, septate ascospores with characteristic wall thickenings, and bacilliform spermatia. *Rinodina* species occur on a wide range of substrates including bark, wood, bryophytes and rock. Revisionary studies in recent decades have dealt with species from the British Isles (Sheard 1967), Antarctica (Lamb 1968), the Benelux (Giralt *et al.* 1997), saxicolous species from Europe (Mayrhofer & Poelt 1979), New Zealand (Mayrhofer 1983), Europe, Africa and Asia (Mayrhofer 1984a), Australia (Mayrhofer 1984b), the Iberian Peninsula (Giralt & Barbero 1995; Giralt & Llimona 1997), Southern Africa (Matzer & Mayrhofer 1996), and corticolous species from the Eastern Alps in Central Europe (Ropin & Mayrhofer 1993), southern Europe and adjacent regions (Giralt & Matzer 1994; Giralt & Mayrhofer 1994a; 1994b; 1995; Giralt *et al.* 1995).

In the Australian region, 35 species have been recorded in the checklist of Filson (1996), including 14 from Tasmania (Kantvilas 1994). The saxicolous taxa (20 species) have been revised by Mayrhofer (1984b) with further studies and additional taxa reported by Mayrhofer *et al.* (1990), Matzer & Mayrhofer (1994), and Matzer *et al.* (1998). However, the corticolous species remain poorly known and those occurring in Tasmania and the temperate regions of Australia are the focus of the present paper.

### Material and methods

The study is based on specimens from the following herbaria: B, BRI, CANB, COLO, G, GZU, H, HO, L, MEL, PERTH, S, STU, UPS, the private collection of Klaus Kalb, and on the field observations of the authors in a wide range of habitats and localities in Tasmania and mainland Australia. Anatomical investigations were made using standard light microscope techniques and measurements were derived from hand-cut sections mounted in water. Routine chemical analyses for the investigation of lichen compounds were undertaken using the standard methods of Culberson & Ammann (1979) and Culberson & Johnson (1982). The study area comprises Tasmania and the southern Australian mainland. However, numerous collections from New Zealand and subtropical Australia were also studied for comparative purposes.

### Taxonomic characters in *Rinodina*

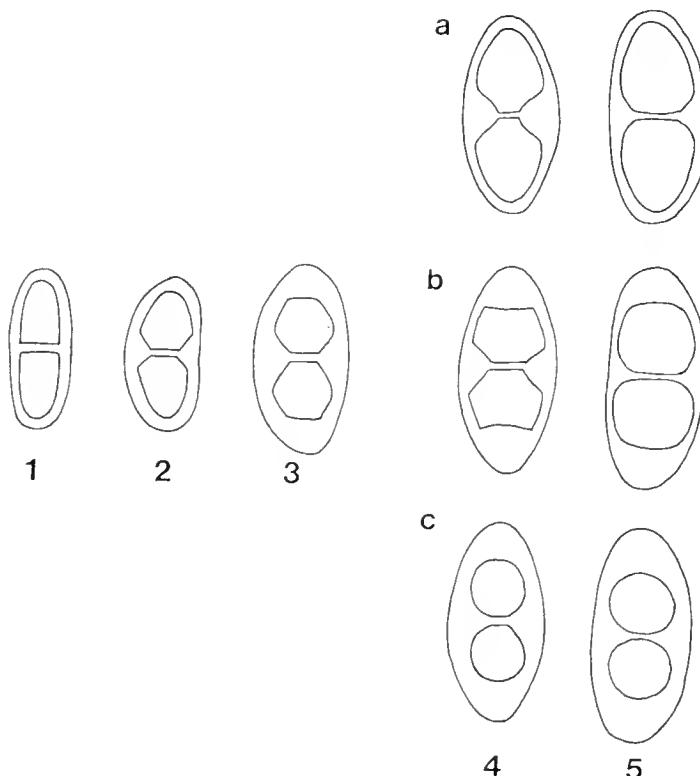
#### Morphology

The gross morphology of the thallus of the species studied is very variable and clearly influenced by habitat and other factors. Nevertheless, a group of species have a very well developed, ± subsquamulose thallus, rather reminiscent of some smaller members of the family Pannariaceae. Thus, at least for these taxa, thallus morphology provides a valuable aid to identification. The formation of blastidia [yeast-like propagules budded from the thallus surface (Poelt 1980)] can be a useful character for recognising *Rinodina australiensis*.

#### Ascospores

Ascospores, notably their size and, more particularly, their characteristic apical and median wall thickenings, have traditionally been the fundamental character for defining the species (Poelt & Mayrhofer 1979, revised compilations by Hafellner *et al.* 1979, Mayrhofer & Poelt 1979, Mayrhofer 1982, 1984a, and modified by Matzer & Mayrhofer 1996). The presence or absence of a torus (i.e. a dark belt in the region of a spore septum) is not always a reliable character for the definition of spore types (Scheidegger 1993, Matzer & Mayrhofer 1996).

The mode of ascospore ontogeny was stressed as being an important character by Giralt (1994) and Giralt & Mayrhofer (1994a, 1994b, 1995). Two main ontogenetic types

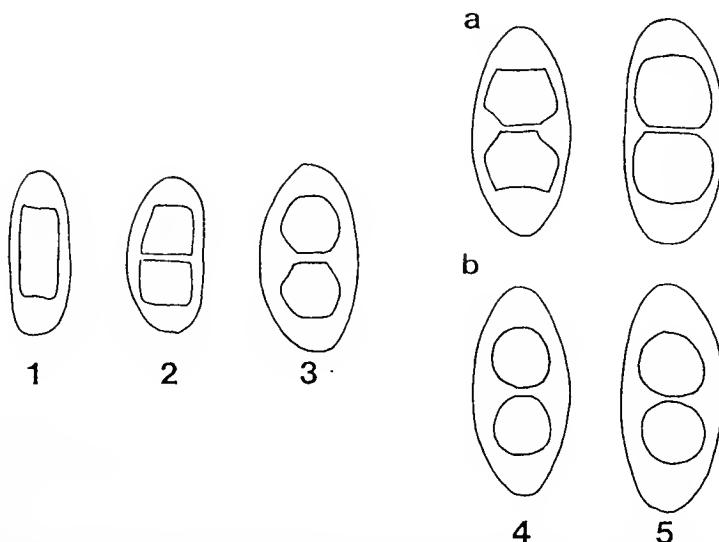


**Fig. 1.** Ascospore ontogenies and ascospore-types: ontogeny of type A: **a** *Physconia*-type ascospores; **b** *Physcia*-type ascospores; **c** *Pachysporaria*-type ascospores. - (1) to (5) sequence of ontogeny-stages (after Giralt & Mayrhofer 1995: 130).

can be observed with respect to the insertion of the septum, which occurs in the earlier stages of ontogeny when the ascospores are still unpigmented: type A, where apical internal spore wall thickenings appear after the insertion of the septum (Fig. 1), and type B, where apical internal wall thickenings appear before the insertion of the septum (Fig. 2). Five stages of ascospore ontogeny can be identified within type A (Fig. 1): (1) septum formation; (2) thickening of the lateral walls at the septum; (3) thickening of the apical walls. Stages 1-3 occur in premature unpigmented ascospores. Stage 4 shows pigmented mature ascospores with the distinct internal wall thickenings that define the ascospore types, whereas stage 5 refers to overmature ascospores with walls becoming more or less uniformly thick. In contrast, ascospores with an ontogeny of type B show apical internal wall thickenings (1) before the insertion of the septum (2) and the thickening of the lateral walls at the septum (3) (Fig. 2). With the exception of *Rinodina conradii* all the taxa treated follow type A ontogeny.

Within the species investigated in detail in the present study, the following types of ascospores were observed:

- (i) *Physconia*-type: ascospores with  $\pm$  pronounced septal wall thickenings, apical thickenings less pronounced or lacking, and lumina rounded at their distal ends; found in *R. pyrina*.
- (ii) *Physcia*-type: septal and apical wall thickenings well developed, spore lumina concave at their distal ends, torus usually developed; found in *R. confusa*, *R. elixii* and *R. obscura*.
- (iii) *Mischoblastia*-type: septal and apical wall thickenings strongly pronounced, forming extremely angular lumina; found in *R. australiensis*.
- (iv) *Pachysporaria*-type: wall thickenings strongly developed around the lumina which are  $\pm$  rounded; found in *R. asperata*, *R. australiensis*, *R. confusa* and *R. dolichospora*.
- (v) *Conradii*-type: uniformly thickened walls and four rounded lumina; found in *R. conradii*.
- (vi) *Orcularia*-type: wall thickenings only at the septum; found in *Anandinea insperata*.



**Fig. 2.** Ascospore ontogenies and ascospore-types: ontogeny of type B; **a** *Dirinaria*-type ascospores; **b** *Pachysporaria*-type ascospores. - (1) to (5) sequence of ontogeny stages (after Giralt & Mayrhofer 1995: 132).

Note that in two species (*R. australieusis* and *R. confusa*) the ascospores could not clearly be assigned to a single spore type. All ascospore characters (wall thickenings, shape of lumina, torus, ornamentation) can be observed in water mounts. However, mounting in dilute KOH is recommended when the material is fresh.

#### *Hymenium*

An interesting anatomical feature of some species is the 'oil paraphyses' that are characterized by the presence of distinctly enlarged cells ('oil cell') with oil-like contents. Such structures were originally described by Poelt & Pelleter (1984) and Giralt *et al.* (1992) in some species of *Caloplaca*, and they have also been detected in some species of *Rinodina* (Giralt & Mayrhofer 1994a, Giralt & Matzer 1994, Matzer & Mayrhofer 1994).

#### *Photobiont*

The photobiont of the species studied is an unidentified green alga with roughly roundish or broadly elongate cells. The size of the cells appears to be consistent for the species, and thus provides an additional taxonomic character. Two broad size classes are discernible: generally <10 µm across and from 10 µm to as much as 20 µm across.

#### *Anatomy of the exciple*

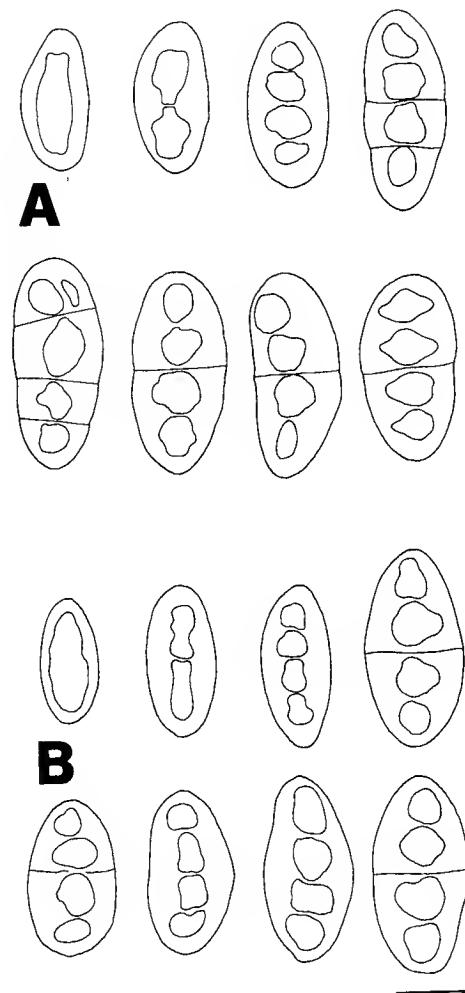
Characters of the exciple, for example, the degree of development of the parathecium, cortex and epinecral layer, have been described and measured for all species, although these are probably of limited use as taxonomic characters. In part, these relate to the age of the apothecia or to features of gross morphology, such as whether they are immersed, adnate or sessile. Furthermore, these characters, especially the development of the epinecral layer, may well be related to habitat.

#### *Ecological and biogeographic patterns*

The majority of the species studied, i.e. *R. asperata*, *R. australieusis*, *R. confusa*, *R. elixii* and *R. obscura*, are found mainly in dry sclerophyll woodland. These species are all endemic to temperate Australia, as are their host trees and shrubs, for example, species of *Acacia*, *Allocasuarina*, *Banksia*, *Callitris*, *Exocarpos* and *Melaleuca*. *Rinodina australiensis* also occurs in mangroves, as does *R. dolichospora*, which was first described from Brazil. Of the remaining species treated, *R. pyrixa* is probably introduced from Europe, as are its hosts, whereas *R. couradii* is a pantropical species quite unrelated to the other taxa in the study area. The relatively high level of endemism of corticolous species contrasts sharply with that displayed by the Australian saxicolous *Rinodina* flora, in which most species also occur in New Zealand and/or other adjacent regions, or are cosmopolitan (Mayrhofer 1984b, Mayrhofer *et al.* 1990, Matzer & Mayrhofer 1994, Matzer *et al.* 1998, Mayrhofer & Matzer, in prep.).

#### **Key to corticolous and lignicolous *Rinodina* in temperate Australia**

1. Ascospores four-celled ..... 2
1. Ascospores two-celled ..... 3
2. Septum in young ascospores inserted after formation of internal wall thickenings (ontogeny of type B, Fig. 2); lumina of immature two-celled ascospores subsymmetrically circular (*Phlyscia*-type) (Fig. 3A) ..... *R. couradii*
2. Septum in young ascospores inserted before formation of internal wall thickenings (ontogeny of type A, Fig. 1); lumina of immature two-celled ascospores bone-shaped (Fig. 3B); a species of subtropical and tropical rainforests ..... *R. connectens* Malme (not treated)



**Fig. 3A.** Ascospores of *Rinodina conradii* (Walpole National Park, *Tibell 14099, GZU*); first row: ontogeny; second row: mature ascospores; **3B.** Ascospores of *Rinodina connectens* (Atherton Tableland, Mt Lewis, 18.iv.1968, W.A. Weber, COLO); first row: ontogeny; second row: mature ascospores. Scale: 10  $\mu\text{m}$ .

3. Most ascospores  $>22 \mu\text{m}$  long; thallus usually well-developed, thick, areolate-crustose to subsquamulose.....4
3. Most ascospores  $<22 \mu\text{m}$  long; thallus variable, often relatively thin.....6
4. All ascospores of the *Pachysporaria*-type, frequently with minute grain-like or droplet-like inclusions (Fig. 10c); photobiont cells  $<10 \mu\text{m}$  wide.....*R. dolichospora*
4. All ascospores of the *Physcia*-type, or at first of the *Mischoblastia*-type and then corresponding to the *Pachysporaria*-type, without inclusions; photobiont cells generally  $>10 \mu\text{m}$  wide .....5
5. Apothecia emerging from thalline warts, often with adhering thallus fragments when young; ascospores of the *Physcia*-type .....*R. elixii*
5. Apothecia  $\pm$  adnate to sessile from the earliest stages; ascospores at first of the *Mischoblastia*-type, then corresponding to the *Pachysporaria*-type ....*R. australiensis*
6. Ascospores generally lacking apical thickenings when mature, of the *Physconia*-type;

photobiont cells mostly  $>15$   $\mu\text{m}$  wide; a species mainly found on exotic trees in disturbed or modified habitats ..... *R. pyrina*

6. Ascospores with apical thickenings of the *Pachysporaria*-, *Mischoblastia*- or *Physcia*-type or without apical, but with distinct septal, thickenings (*Orcularia*-type); photobiont cells  $<15$   $\mu\text{m}$  wide; species mainly of native vegetation..... 7

7. Ascospores without apical, but with distinct, septal thickenings (*Orcularia*-type); spermatia filiform ..... *Amandinea insperata*

7. Ascospores with apical thickenings; spermatia bacilliform ..... 8

8. Thallus often inapparent to absent; apothecia initially  $\pm$  immersed,  $\pm$  lecideine when mature; ascospores of the *Physcia*-type ..... *R. obscura*

8. Thallus persistent; apothecia adnate to sessile from the beginning, clearly lecanorine; ascospores of the *Mischoblastia*-, *Physcia*- or *Pachysporaria*-type ..... 9

9. Thallus rimose-areolate or verrucose; ascospores of the *Pachysporaria*-type ..... *R. asperata*

9. Thallus areolate to subsquamulose, becoming lobulate, granular or microphylline to blastidiate; ascospores at first of the *Mischoblastia*-type or *Physcia*-type, then corresponding to the *Pachysporaria*-type ..... 10

10. Ascospores at first with internal thickenings of the *Mischoblastia*-type; torus indistinct ..... *R. australiensis*

10. Ascospores at first with internal thickenings of the *Physcia*-type; torus distinct ..... *R. confusa*

**1. *Rinodina asperata* (Shirley) Kantvilas, Pap. Proc. R. Soc. Tasmania 122: 65 (1988); *Bnella polospora* var. *asperata* Shirley, Pap. Proc. R. Soc. Tasmania (1893): 218 (1894). Type: Australia, Tasmania, Fork Creek, on bark; W.A. Weymouth 144 (holotype BRI!, isotype G!).**

Exs.: Obermayer: Lichenotheca Graecensis 97 (ASU, B, C, CANB, CANL, E, ESS, G, GZU, H, HMAS, LE, M, MAF, MN, O, TNS, UPS, Kalb, Vezda)

*Thallus* crustose, smooth and thin or, more commonly, rather thick, rimose-areolate or verrucose, at times rather abraded, matt, dull olive-green to brownish grey; areoles continuous or  $\pm$  dispersed, mostly c. 0.1–0.3 mm wide; prothallus absent. *Photobiont* cells 6–10  $\times$  5–9.5  $\mu\text{m}$ . *Chemistry*: no lichen substances detected by t.l.c.

*Apothecia* 0.25–0.8(–1.2) mm diam., typically numerous, scattered or crowded, lecanorine, sessile or adnate. *Thalline margin* prominent, concolorous with the thallus, smooth and entire, or crenulate to verruculose, generally persistent; cortex 15–40  $\mu\text{m}$  thick. *Disc* plane, sometimes becoming markedly convex or uneven with age, brown to blackish brown, matt. *Epiphymenium* 10–15  $\mu\text{m}$  tall, brown to olive-brown, unchanged in KOH. *Hymenium* hyaline, 70–90(–100)  $\mu\text{m}$  tall. *Hypothecium* 60–80(–100)  $\mu\text{m}$  deep, hyaline to light yellowish brown. *Paraphyses* simple or branched, not separating easily, 1.5–2  $\mu\text{m}$  thick, with apices pigmented brown to olive-brown, sometimes clavate to capitate, 2–5  $\mu\text{m}$  wide; oil paraphyses sometimes developed. *Asci* eight-spored. *Ascospores* (Fig. 4) two-celled, of the *Pachysporaria*-type, smooth-walled, pale olive to brown, (15–)16–21(–22)  $\times$  (7–)8–11(–12)  $\mu\text{m}$ ; torus and septum indistinct; ontogeny of type A. *Spermogonia* not observed.

*Comments*: The *Pachysporaria*-type ascospores of *R. asperata* ally this species with *R. dolichospora*, although these two taxa are readily separable by a wide range of macroscopic and anatomical characters: *R. dolichospora* has substantially larger ascospores, a rather well developed, subsquamulose thallus and apothecia with a frequently incomplete thalline margin. Furthermore, although the two taxa have been

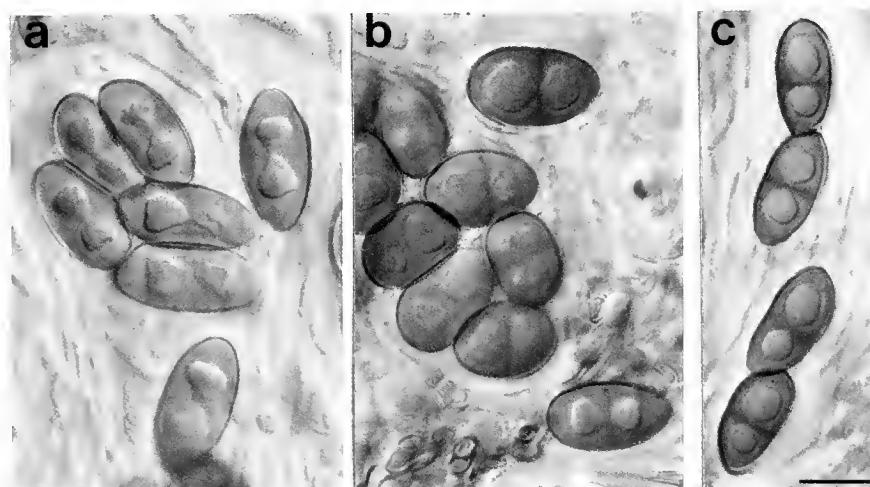


Fig. 4. *Rinodina asperata* (a, b isotype, c Mayrhofer 5570): mature ascospores. Scale: 10  $\mu\text{m}$ .

known to co-occur, they nevertheless tend to have rather different ecologies, *R. asperata* being a dry woodland species whereas *R. dolichospora* is known only from mangroves. In the field and macroscopically, *R. asperata* is more likely to be confused with *R. obscura*, which also has a crustose thallus and occurs in similar dry habitats. Microscopically these two species differ completely because *R. obscura* has *Physcia*-type ascospores with a distinct torus, albeit of similar size. However, even macroscopically they are usually distinguishable, because the thalline apothecial margin in *R. asperata* is usually well developed, whereas in *R. obscura* it is frequently reduced to the extent that the apothecia appear lecideine. Some confusion is also possible between *R. asperata* and *R. pyrina*; these taxa are best distinguished by their ascospores, although they differ further by the larger algal cells of the latter and by their different ecologies (see under *R. pyrina*). Also similar is *R. australiensis*, especially some of the smaller-spored individuals which, like *R. asperata*, occur in dry sclerophyll habitats. This species is distinguished by its generally thicker, crustose to subsquamulose thallus and by its ascospores which are initially of the *Mischoblastia*-type and later develop into the *Pachysporaria*-type.

With respect to the shape and measurements of the ascospores, *R. asperata* comes close to *R. dispersa* Malme described from South America (Malme 1902). The latter species is separated by the well developed, subsquamulose thallus and the mature ascospores that possess a distinct torus.

One specimen [Wilson 694 from Camperdown, Victoria (G)] remains enigmatic, but we provisionally include it in *R. asperata*. It has ascospores in which the *Pachysporaria*-type thickenings are rather less pronounced than usual but grade instead into the *Physcia*- or *Milvina*-types. With respect to spore and photobiont cell size, this specimen accords well with *R. asperata*. We have also observed short, bacilliform spermatia, 3–4  $\times$  1–1.5  $\mu\text{m}$ .

**Ecology and distribution:** *Rinodina asperata* is by far the most common and widespread corticolous species of the genus in the study area, known from southern mainland Australia (all States) and eastern Tasmania (Fig. 5). It occurs in dry sclerophyll forests and open woodlands, mainly in the lowlands but also extending to c. 1400 m above sea level at lower latitudes. It grows on a wide range of understorey trees and shrubs, for example species of *Allocasuarina*, *Acacia*, *Banksia* and *Exocarpos*, and rarely also on *Eucalyptus*. Occasionally it may also occur on exotic trees in modified or disturbed habitats such as pasture, although in such habitats it is more likely to be replaced by *R. pyrina*.

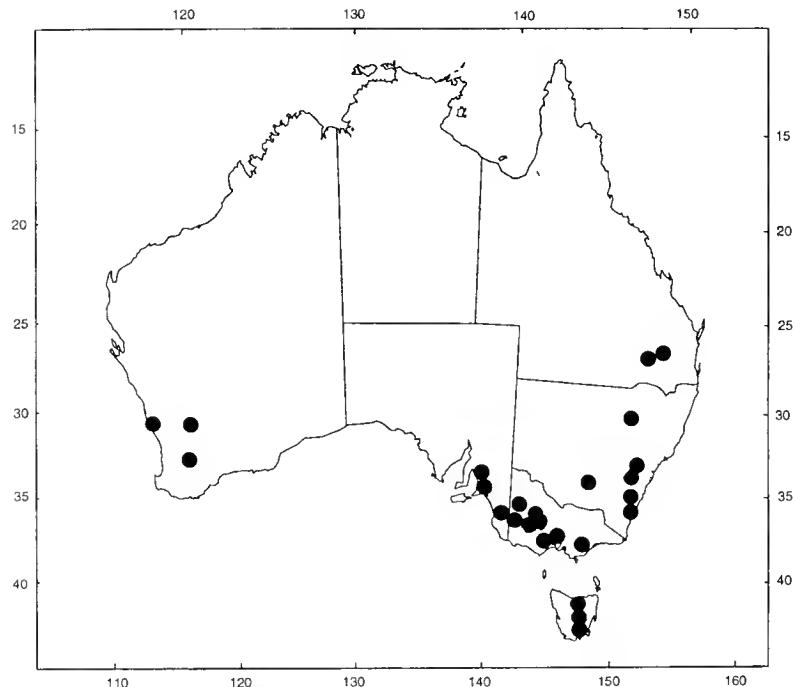


Fig. 5. Distribution of *Rinodina asperata*.

This species grows mainly on living or dead bark of twigs up to c. 5 cm diam., and is a typical component of a usually very diverse and well developed association dominated by crustose lichens. Common species with which *R. asperata* often occurs include *Buellia (Hafellia) dissia*, *Candelariella xanthostigmoides*, *Perpusaria gibberosa*, *P. trimera*, *Pyrrhospora laeta*, *Ramboldia brunneocarpa*, *Tephromela atra*, unidentified species of *Caloplaca* and the Lecideaceae and Bacidiaceae *sens. lat.*, as well as the macrolichens *Flavoparmelia rutilans*, *Parmelia pseudorelicina* and *Usnea iuuenis*. Frequently the *Rinodina* is in rather poor condition within this lichen community, and being overgrown by other species, particularly *Candelariella*.

*Additional specimens examined:* WESTERN AUSTRALIA: Yanchep State Forest, Picnic Area N of Yanchep National Park, N of Perth, *D. M. & H. Mayrhofer* 8574, 28.viii.1988 (GZU); Albany Hwy, 2 km S of Beaufort, S of Arthur River, *D. M. & H. Mayrhofer* 8553, 25.viii.1988 (GZU, HO, PERTH, Mayrhofer); 7793, 7796 (GZU); 8541 (CANB); SE side of Ballidu, *A.S. George* s.n., 26.iii.1960 (MEL). SOUTH AUSTRALIA: Hillside in Torrens Gorge, near Castanbul, 16 km NE of Adelaide, *M. & H. Mayrhofer* 2695, 12.viii.1981 (GZU); Fred Ratteis Scrub, 7 km W of Springton, *M. & H. Mayrhofer* 2702, 6657, 12.viii.1981 (GZU); 6656 (HO); Kuitpo Forest, 10 km E of Willunga, *M. & H. Mayrhofer* 6663a, 14.viii.1981 (GZU); 4700 (HO); Kyeema Conservation Park, 21 km E of Willunga, *M. & H. Mayrhofer* 6675, 6678, 14.viii.1981 (GZU); Christmas Rock, 29 km S of Keith on Dukes Highway, *M. & H. Mayrhofer* 2886, 15.viii.1981 (GZU). QUEENSLAND: Newmarket, Sedgley Park, *R. Rogers & C. Scarlett* 4784, 11.ix.1975 (BRI); Bunya Mountains, Mt Mowbullan, 1050 m, *K. Kalb* 21769 & *R. Rogers*, 14.viii.1988 (Kalb). NEW SOUTH WALES: New England, Armidale District, 35 km NW of Armidale, Parlour Mountain Area, *H. Mayrhofer* 4651 & *J. Williams*, 11.x.1981 (GZU); 5405 (HO); Great Dividing Range, Jenolan Caves, SW of Katoomba, *M. & H. Mayrhofer* 4649, 30.ix.1981 (GZU); 5370 (HO); Wanganderry Tableland, Lake Burratorong, near Wollondilly River, E of Byrnes Bay, SSW of 'The Oaks', *H. Mayrhofer* 4670, 3.x.1981 (GZU); Buckenbowra River Estuary, 7.5 km W of Batemans Bay, *K. Kalb* 18787 & *J.A. Elix*, 4.viii.1988 (Kalb); Burril Lake, 5 km SW of Ulladulla, *H. Streitmann* 10685, 28.xii.1980 (B, CANB, H); Ingalba Nature Reserve, 9 km W of Temora, *J.A. Curnow* 1594, 5.x.1987 (CANB); Mt

Kaputar National Park, Repeater Station near Kaputar Rocks Lookout, 1450m, *P. Merotsy* 384, 8.ii.1987 (BRI). AUSTRALIAN CAPITAL TERRITORY: Condor Creek, c. 25 km W of Canberra, *H. Mayrhofer* 4658, 1.ix.1981 (GZU); 5344 (HO); Molongolo Gorge Reserve, 14 km E of Canberra, *H. Mayrhofer* 10991, 10993, 26.vii.1992 (GZU). VICTORIA: without locality, *C. Knight* 251, 1887 (G, as *Rinodiua obscura*); Maffra, *F.R.M. Wilson* 698, 1891 (G, as *Rinodina metabolica*); Kilmore, *F.R.M. Wilson*, 13.v.1896 (S, as *R. metabolica*); Little Desert, S of Kaniva, *M. & H. Mayrhofer* 5577, 16.viii.1981 (GZU, HO, MEL, Mayrhofer); 6641 (GZU); Little Desert, road from Kaniva to Edenhope, at the mill, 20 km S of Kaniva, *R. Filson* 17078, 16.viii.1981 (MEL); Copi Flats, S of Wyperfield National Park, 125 km N of Horsham, *M. & H. Mayrhofer* 4620, 4695, 18.viii.1981 (GZU); 13266 (GZU, HO); Brisbane Ranges, Little River Gorge, c. 25 km S of Bacchus Marsh, *R. Filson & H. Mayrhofer* 3172, 18.x.1981 (GZU); summit of Ben Nevis, Mount Cole State Forest, 25 km E of Ararat, *M. & H. Mayrhofer* 5570, 5588, 19.viii.1981 (GZU); 1 km N of Wail Forestry Nursery, 4 km SW of Dimboola, *M. & H. Mayrhofer* 2853, 4693, 18.viii.1981 (GZU); northern Grampians, Flat Rock, 25 km SE of Horsham, *M. & H. Mayrhofer* 6686, 17.viii.1981 (GZU); Mount Arapiles Forest Park, 35 km W of Horsham, *M. & H. Mayrhofer* 6639 (GZU, Mayrhofer); Gippsland, Agnes Falls Reserve, NW of Welshpool, *D. & H. Mayrhofer* 11520 & *E. Hierzer*, 29.vii.1992 (GZU); 11525 (GZU, MEL); Gippsland, Buchan Caves Reserve, *D. & H. Mayrhofer* 11551 & *E. Hierzer*, 28.vii.1992 (CANB, GZU). TASMANIA: Mt Wellington, 19.ix.1885. *R.A. Bastow* (H); along road to Bothwell, c. 1 km south of Apsley, *G. Kantvilas* 269/93 & *J.A. Elix*, 7.xii.1993 (HO); Freycinet National Park, Isthmus Track between Wineglass Bay and Hazards Beach, *H. Mayrhofer* 13403, 16.xi.1996 (GZU); Peppermint Hill, approx. 1 km W of New Norfolk, *H. Mayrhofer* 13221, 13415 & *G. Kantvilas*, 19.xi.1996 (GZU); 13414 (HO); Site EE22, 2 km W of New Norfolk along Glenora Road, *G. Kantvilas*, 19.ii.1997 (HO); Site EE25, 2 km S of Howden, near the Powder Jetty, *G. Kantvilas* 192/97, 21.v.1997 (HO); Tasman Peninsula, Cripps Creek, White Beach, *L. Cave*, 5.x.1995 (HO); Hummocky Hills, *A.V. Ratkowsky*, 20.ix.1992 (HO); Grass Tree Hill, *G. Kantvilas* 1014/81, 29.ix.1981 (HO); Launceston, Trevallyn State Recreation Area, *A.V. Ratkowsky*, 12.ii.1992 (HO); Mortimer Bay, *G. Kantvilas* 180/81, 15.iii.1981 (HO); Tunbridge, *G. Kantvilas* 159/98, 9.ix.1998 (HO); Cape Contrariety, *G. Kantvilas* 183/98, 25.ix.1998 (HO).

**2. *Rinodina australiensis* Müll. Arg., *Hedwigia* 32: 123 (1893). Type: Australia, Victoria, by seaside, on *Bauksia serrata*, *F.R.M. Wilson* 368, 1892 (lectotype here designated G!).**

*Thallus* crustose, typically very thick and areolate to subsquamulose, dingy olive-grey to brownish grey; areoles contiguous to ± discrete, mostly 0.1–0.5 mm wide, convex to unevenly verruculose or minutely lobulate or granular, at times becoming blastidiate; prothallus absent. *Photobiont* cells 10–15 × 8–14 µm. *Chemistry*: no lichen substances detected by t.l.c.

*Apothecia* 0.3–1 mm diam., scattered or crowded, lecanorine, adnate or sometimes sessile, rather sunken when young. *Thalline margin* prominent, entire or sometimes incomplete, smooth to crenulate, generally persistent but becoming rather thin and sometimes partially excluded when old; cortex indistinct to distinct, c. 10–20 µm thick, I+ faintly blue (thin sections). *Disc* plane at first, usually becoming markedly convex, ± smooth, reddish brown to dark brown to blackish, matt. *Epiphytum* to 10 µm tall, brown, unchanged in KOH. *Hyphenum* hyaline, 100–120 µm tall. *Hypothecium* 50–80 (–100) µm deep, pale yellowish brown, unchanged in KOH. *Paraphyses* not separating easily, simple or occasionally branched, 1–1.5 µm thick, with apices pigmented brownish, capitate, 3–5 µm wide; oil paraphyses typically abundant, 4–6.5 µm thick. *Ascospores* (Fig. 6) two-celled, at first with internal wall thickenings of the *Mischoblastia*-type, then corresponding to the *Pachysporaria*-type, smooth to finely ornamented, brown, (18)–22–31(–33) × (9)–10–15(–16) µm, lacking a torus, with the septum not or only barely visible; ontogeny of type A. *Spermatogonia* immersed, found mainly at the base of the apothecia. *Spermatia* (Fig. 6d) shortly bacilliform, 3–4 × 1 µm.

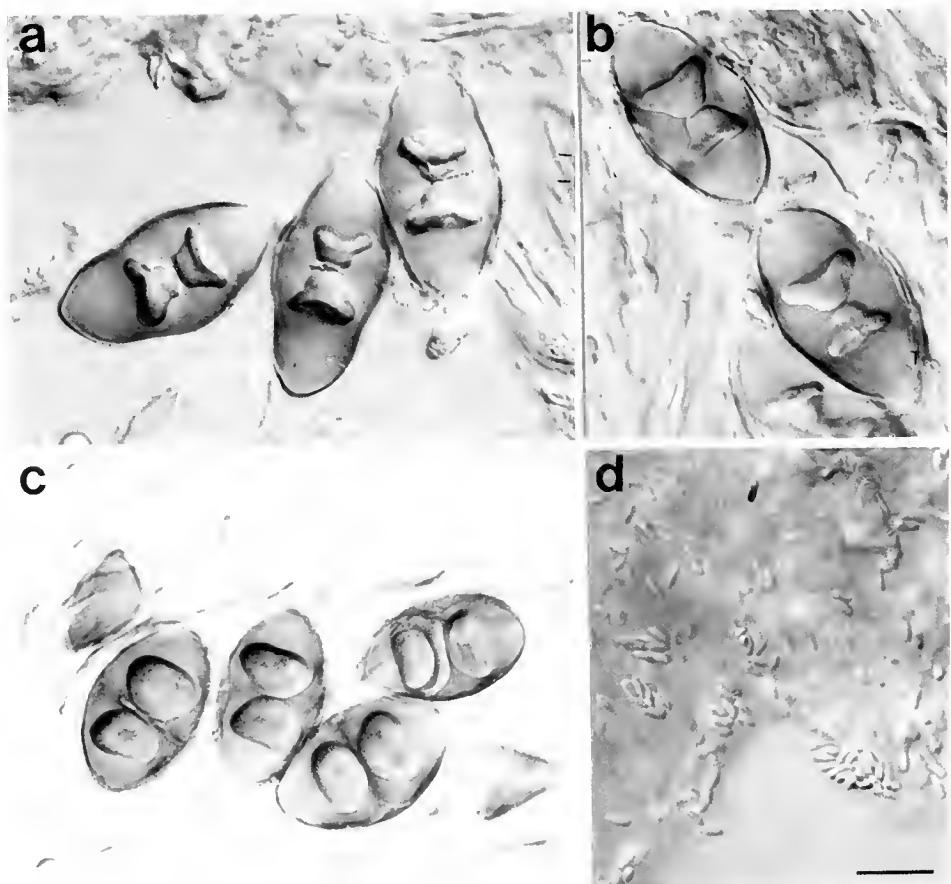


Fig. 6. *Rinodina australiensis* (a-c holotype, d Mayrhofer 2638): premature (a, b) and mature (c) ascospores; short bacilliform spermatia (d). Scale: 10  $\mu$ m.

**Taxonomic note:** The cited sample of the type material of *Rinodina australiensis* was first reported as *Rinodina colobinoides* (Müller 1893a). A second specimen from Queensland (Slirley 40) mentioned by Müller (1893b: 124) in the protologue, was not available for study.

**Comments:** In general, *R. australiensis* is characterized best by its ascospores, at first with internal wall thickenings of the *Mischoblastia*-type, and then corresponding to the *Pachysporaria*-type, and by its thick, well-developed, areolate-crustose to subsquamulose thallus. Morphologically it is rather similar to *R. confusa*, *R. dolichospora* and *R. elixii*, which also have such a thallus. The first of these species is characterized by smaller ascospores of the *Physcia*- or *Pachysporaria*-type with a distinct torus. The other two taxa have large ascospores, *R. elixii* of the *Physcia*-type, and *R. dolichospora* of the *Pachysporaria*-type, frequently with minute, grain-like or droplet-like inclusions. Oil paraphyses are typically very abundant in *R. australiensis*, and the algal cells are relatively large in comparison, for example, to *R. asperata* and *R. dolichospora* with which it may sometimes occur. The former also differs in several other characters, such as having a somewhat thinner thallus and small *Pachysporaria*-type ascospores.

Within this species, we have observed an unusually wide range of ascospore sizes, with the largest being found in asci where the number of mature ascospores is reduced to 4–6. Two specimens from South Australia are particularly unusual in that their ascospores

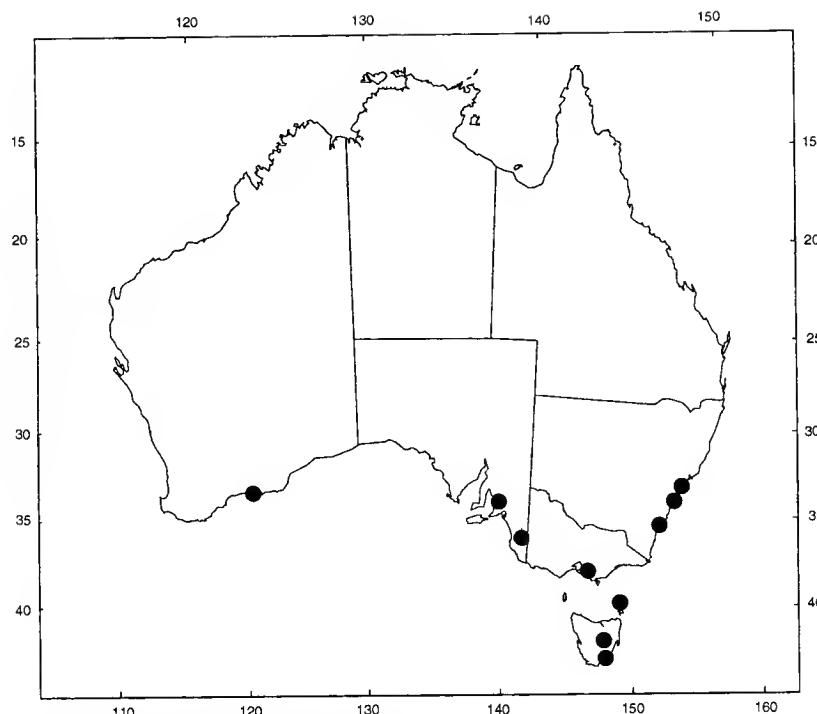


Fig. 7. Distribution of *Rinodina austroliensis*.

are very short and rather more squat in shape (18–23 × 10–13 µm). This material also has an exceptionally granular, blastidiate thallus, although this may be due to the drier, more exposed habitat. Clearly this species deserves further collection and study, and may require subdivision in the future.

*Rinodina austroliensis* is closely related to the saxicolous maritime *R. blastidiata* Matzer & H. Mayrhofer with which it shares characters of ascospores, oil paraphyses and short spermatia. The latter species is distinguished by the extensive formation of blastidia, the less frequent apothecia, and by its habitat: hard siliceous coastal rocks in south-eastern Australia (South Australia, southern New South Wales, Victoria and Tasmania) and New Zealand (Matzer & Mayrhofer 1994). Although the differences between *R. austroliensis* and *R. blastidiata* are not great, we refrain from combining them into one taxon: both are regarded as a pair of closely related species, one of which is saxicolous and the other corticolous or lignicolous. Further examples of such pairs of related species are: the saxicolous *R. gennarii* Bagl. and the corticolous *R. oleae* Bagl. (Matzer & Mayrhofer 1996); and the saxicolous *R. beccariana* Bagl. and the corticolous *R. roboris* (Duf. ex Nyl.) Arnold var. *roboris* (Mayrhofer *et al.* 1993). Additional species closely related to *R. austroliensis* include the saxicolous *R. teichophila* (Nyl.) Arnold from the Northern Hemisphere, *R. teichophiloides* (Stizenb.) Zahlbr. from South Africa, and *R. reagens* Matzer & H. Mayrhofer from South Africa and New Zealand (Matzer & Mayrhofer 1994). The illustration of ascospores under the name *R. austroliensis* (Filson & Rogers 1979: 157) refers to *R. elixii*.

**Ecology and distribution:** *Rinodina austroliensis* is a lowland species, found in mangroves and sclerophyllous woodland and heathland (Fig. 7). It has been reported from the bark of *Avicennia marina*, *Bursaria spinosa*, *Melaleuca ericifolia*, *Banksia serrata* and *Allocasuarina verticillata*. In mangroves, the species was associated with scattered, poorly developed, unidentified crustose lichens, species of *Pyxine* and

*Parmotrema*, and, rarely, *Rinodina asperata* and *R. dolichospora*. However, in sclerophyllous vegetation, especially in Tasmania, it occurs in a species rich community comprising *Teloschistes chrysophthalmus*, *Xanthoria lignata*, *Rinodina asperata*, species of *Caloplaca* and *Candelariella* and other crustose lichens.

*Additional specimens examined:* WESTERN AUSTRALIA: Recherche Archipelago, Boxer Island, *J.H. Willis*, 9.xi.1950 (MEL). SOUTH AUSTRALIA: Christmas Rocks, 29 km S of Keith on Duke Highway, *M. & H. Mayrhofer* 4683, 15.viii.1981 (GZU, HO); Fred Ratteis Scrub, 7 km W of Springton, *M. & H. Mayrhofer* 2702, 12.viii.1981 (GZU). NEW SOUTH WALES: Botany Bay, S of Sydney, Towra Point, *M. & H. Mayrhofer* 2638, 23.viii.1981 (GZU); Hawkesbury River, Mangrove Creek, near Spencer, *W. & H. Mayrhofer* 6565, 4.i.1985 (GZU); Hawkesbury River, N of Spencer, *A. & P. Archer, A. & K. Kalb* 26647, 11.viii.1992 (Kalb); Patonga, Patonga Creek, N of Sydney, *A. & P. Archer, A. & K. Kalb* 25932, 25939, 10.viii.1992 (Kalb); Buckenbowra River, 7.5 km WNW of Batemans Bay, *G. Thor* 4828, 2.xi.1985 (S); same locality, *J.A. Elix & K. Kalb* 18232, 18246, 4.viii.1988 (Kalb). VICTORIA: Westernport Bay, Cribb Point, *N. Stevens*, 15.v.1978 (BRI). TASMANIA: Bass Strait, Furneaux Group, Flinders Island, E side of Long Point, *J. S. Whinray*, 12.v.1970 (MEL); Tunbridge, *G. Kantvilas* 160/98, 166/98, 9.ix.1998 (HO); Cape Contraristy, *G. Kantvilas* 182/98, 25.ix.1998 (HO).

### 3. *Rinodina confusa* H. Mayrhofer & Kantvilas *sp. nov.*

Thallus crustosus, areolatus ad subsquamulosus, sordide olivaceo-griseus ad olivaceo-brunneus; areolae dispersae ad contiguae,  $\pm$  planae sed demum abrasae, lobulatae, granulares vel microphyllinae, interdum  $\pm$  blastidiatae. Apothecia dispersa vel paulum aggregata, lecanorina vel lecideina, sessilia. Margo thallina infirme evoluta, margo propria distincta. Ascosporae bicellulares, inspissationibus internis parietis primum typo 'Physcia' (raro ad typum 'Mischoblastia' vergentibus), demum typo 'Pachysporaria' congruentibus, brunneae ad fuscae,  $\pm$  laeves, 16–20  $\times$  8–10.5  $\mu\text{m}$ , toro distincto, in omnibus typis morphologicis ascosporarum visibili.

*Type:* South Australia, Fred Ratteis Scrub, 7 km W of Springton, on bark of *Casuarina stricta*, 500–530 m altitude, *M. & H. Mayrhofer* 2700, 12.viii.1981 (holotype GZU; isotype HO).

*Thallus* crustose, thick and areolate to subsquamulose, dingy olive-grey to olive-brown; areoles dispersed to contiguous, rather indeterminate,  $\pm$  plane but becoming abraded, lobulate, granular or microphylline, sometimes  $\pm$  blastidiatae; prothallus absent. *Photobiont* cells 10–13  $\times$  9–11  $\mu\text{m}$ . *Chemistry:* no lichen substances detected by t.l.c.

*Apothecia* 0.2–0.6(–0.8) mm diam., scattered to somewhat clustered, lecanorine to lecideine, mostly sessile. *Thalline margin* usually poorly developed, incomplete, smooth or more commonly nodulose, mainly on the lower side of the apothecium, becoming increasingly excluded with age; proper margin usually distinct, concolorous with the disc, reddish brown to blackish brown; cortex indistinct. *Disc* plane, occasionally becoming convex, smooth to slightly rugose, reddish brown to blackish brown, matt. *Epiphyllum* 10–15  $\mu\text{m}$  tall, red-brown to dark brown, unchanged in KOH. *Hymenium* hyaline, 90–110  $\mu\text{m}$  tall. *Hypothecium* hyaline, c. 50  $\mu\text{m}$  deep. *Parathecium* well developed, pigmented within. *Paraphyses* not separating easily, mainly simple and branched only near the apices, 1.5–2  $\mu\text{m}$  thick, with apices pigmented brownish, capitate, 3–4  $\mu\text{m}$  wide; oil paraphyses not observed. *Asci* eight-spored. *Ascospores* (Fig. 8) two-celled, at first with internal thickenings of the *Physcia*-type (rarely grading into the *Mischoblastia*-type), then corresponding to the *Pachysporaria*-type, brown to dark brown,  $\pm$  smooth-walled, 16–20  $\times$  8–10.5  $\mu\text{m}$ , with a distinct torus visible in all morphological types; septum visible from the earliest stages, persistent; ontogeny of type A. *Spermatogonia* not found.

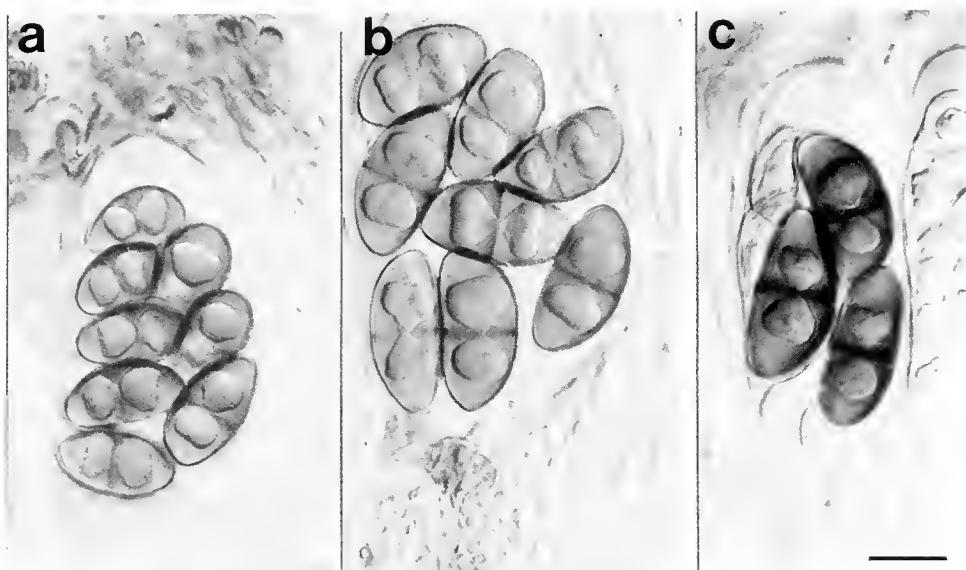


Fig. 8. *Rinodina confusa* (holotype): mature ascospores. Scale: 10  $\mu$ m.

*Comments:* As the name implies, this species possesses many enigmatic characters and is therefore difficult to characterise simply. For example, the variability in the spore thickenings is remarkable in that even adjacent asci may contain ascospores of quite different types. Although for the most part, the taxonomy of *Rinodina* depends strongly on spore morphology, such variation is not unique and has also been reported by Giralt & Mayrhofer (1995) in the Macaronesian species, *R. abolescens* H. Magn. Thus in this regard in the Australian flora, *R. confusa* is characterised best by its variable ascospores.

Morphologically, *R. confusa* is most similar to the subsquamulose taxa, *R. australiensis*, *R. dolichospora* and *R. elixii*, but these species all have significantly larger ascospores. *R. dolichospora* also has a completely different ecology, being known only from relatively moist habitats. *Rinodina elixii* differs further in having apothecia which are rather immersed in thalline warts when young. Frequently the thallus of *R. confusa* may become very abraded and granular, and thus may resemble the rather blastidiate forms of *R. australiensis* and, to a lesser extent, *R. asperata*. Nevertheless, the thallus in *R. asperata* is never so well developed, and this taxon also differs in having persistently lecanorine apothecia and small algal cells. Separation from *R. australiensis* is more difficult, and whereas subtle thalline characters may be of help, this can be achieved with certainty only by careful study of the ascospores.

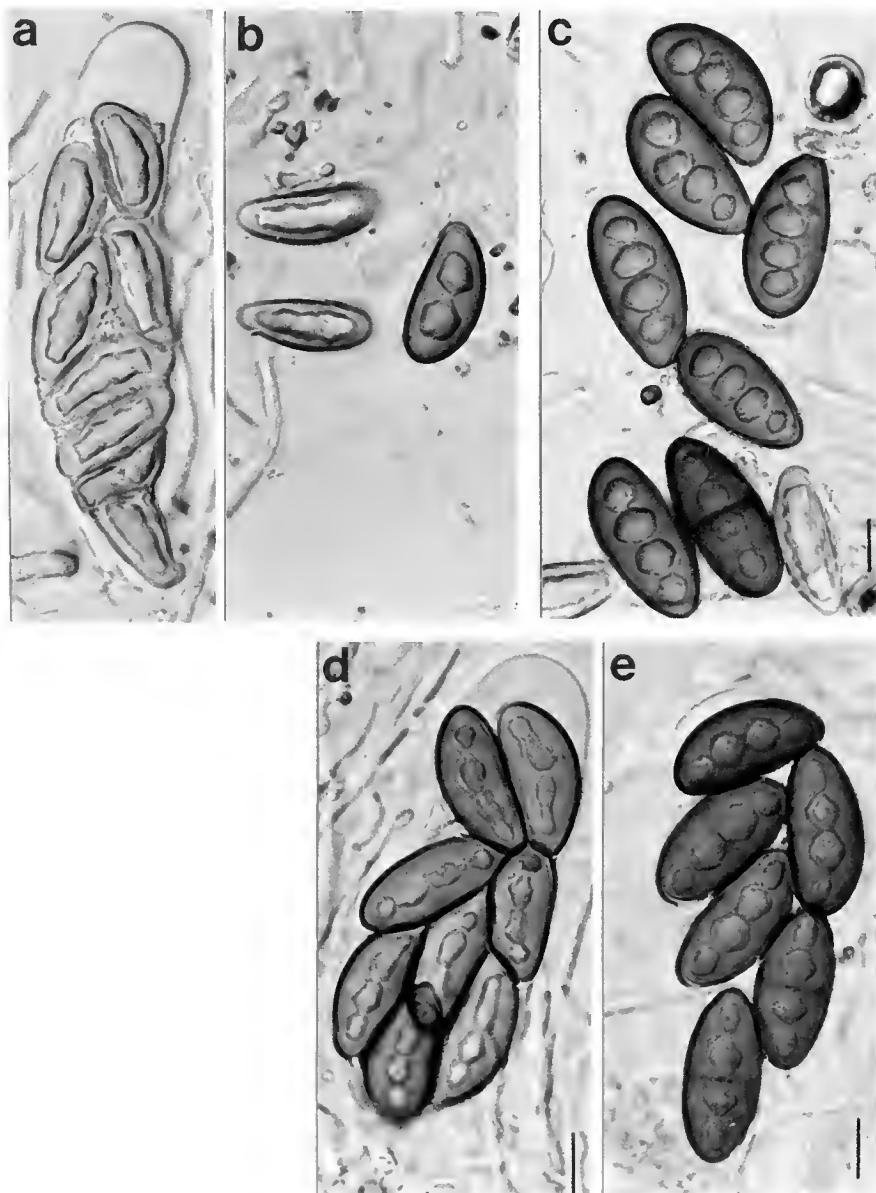
There remains one specimen (A.C.T.: Molongolo Gorge Reserve, Mayrhofer 10983 & Elix, GZU), clearly closely related to *R. confusa*, which we have been unable to place with certainty. It has a very similar thallus, although neither abraded nor lobulate-granular, and persistently lecanorine apothecia. This specimen has the variable ascospores of *R. confusa*, but these are marginally shorter and narrower, 15–19  $\times$  7.5–9  $\mu$ m, with a thinner hymenium (70–90  $\mu$ m) and larger photobiont cells (15–25  $\times$  13–20  $\mu$ m). Further collections of such material are required in order to identify it accurately.

*R. confusa* is related to the Macaronesian species *R. abolescens* which is distinguished by the presence of a distinct, I+ blue cortex and a much thinner and discontinuous thallus (Giralt & Mayrhofer 1995).

*Ecology and distribution:* *Rinodina confusa* is only known from the type locality, where it grew abundantly on the rough bark of *Casuarina stricta* in dry sclerophyll forest. Associated lichens, growing on the specimens, include depauperate fragments of *Physcia adscendens* and species of *Candelariella* and *Caloplaca*.

4. *Rinodina conradii* Körb. *Syst. Lich. Germ.*: 123 (1855). *Type*: without locality, 'Typenherbar Körber' (lectotype, here designated, L!).

*Thallus* crustose, thin or evanescent to rather thick and well developed, seldom areolate, finely verrucose to granular, cream-coloured to grey-brown or brown; prothallus absent. *Photobiont* cells  $13-20 \times 12-15 \mu\text{m}$ . *Chemistry*: no lichen substances detected by t.l.c.



**Fig. 9.** a-c *Rinodina conradii* (Tibell 14099, GZU). a ascus with young ascospores where internal spore wall thickenings appear before the insertion of the septum; b immature ascospore (right) as of the *Physcia*-type; c mature ascospores. d-f *Rinodina connectens* (Atherton Tableland, Mt Lewis, 18.iv.1968, W.A. Weber, COLO). d immature ascospores with bone-shaped lumina; e mature ascospores. Scales: 10  $\mu\text{m}$

*Apothecia* 0.2–1 mm diam., scattered or crowded, lecanorine, sessile to adnate. *Thalline margin* prominent, concolorous with the thallus, smooth and entire, or softly ridged, generally persistent; cortex indistinct. *Disc* plane, soon becoming convex, reddish brown, black-brown to black, matt. *Epiphyllum* 10–15 µm tall, red-brown, unchanged in KOH. *Hymenium* hyaline, 120–150 µm tall. *Hypothecium* hyaline, 50–100 µm deep. *Parathecium* 25–40 µm thick, hyaline except at the upper edge. *Paraphyses* separating easily, 1.5–2 µm thick; apices capitate, pigmented red-brown, 3–4 µm wide; oil paraphyses frequent, 4.5–6 µm thick. *Asci* eight-spored. *Ascospores* (Figs 3a, 9a–c) 4-celled when mature, lumina of immature two-celled ascospores like those of the *Physcia*-type, 23–29.5 × (10–)11–13 µm; torus indistinct; central septum distinct and persistent, other septa very indistinct; ontogeny of type B (Fig. 2). *Spermagonia* not observed.

*Taxonomic note:* Körber (1855) listed three localities in his description of *Rinodina conradii*. There is only one specimen, without locality or annotation, in his herbarium which matches well with his description; this we designate as the lectotype.

*Comments:* *Rinodina conradii* is an extremely variable species as regards the morphology of the thallus and the structure of the apothecia. It is well characterised and separated from the other species treated by its ascospores, which are four-celled when mature. In young ascospores, the septum is inserted after the formation of internal apical wall thickenings. In contrast, *R. connectens* Malme, a species described from subtropical South America and also occurring in subtropical to tropical rainforests of Queensland, has four-celled ascospores (when mature) but, in young ascospores, the septum is inserted before the formation of internal wall thickenings and the lumina of premature two-celled ascospores are bone-shaped rather than *Physcia*-like (Figs. 3B, 9d–e).

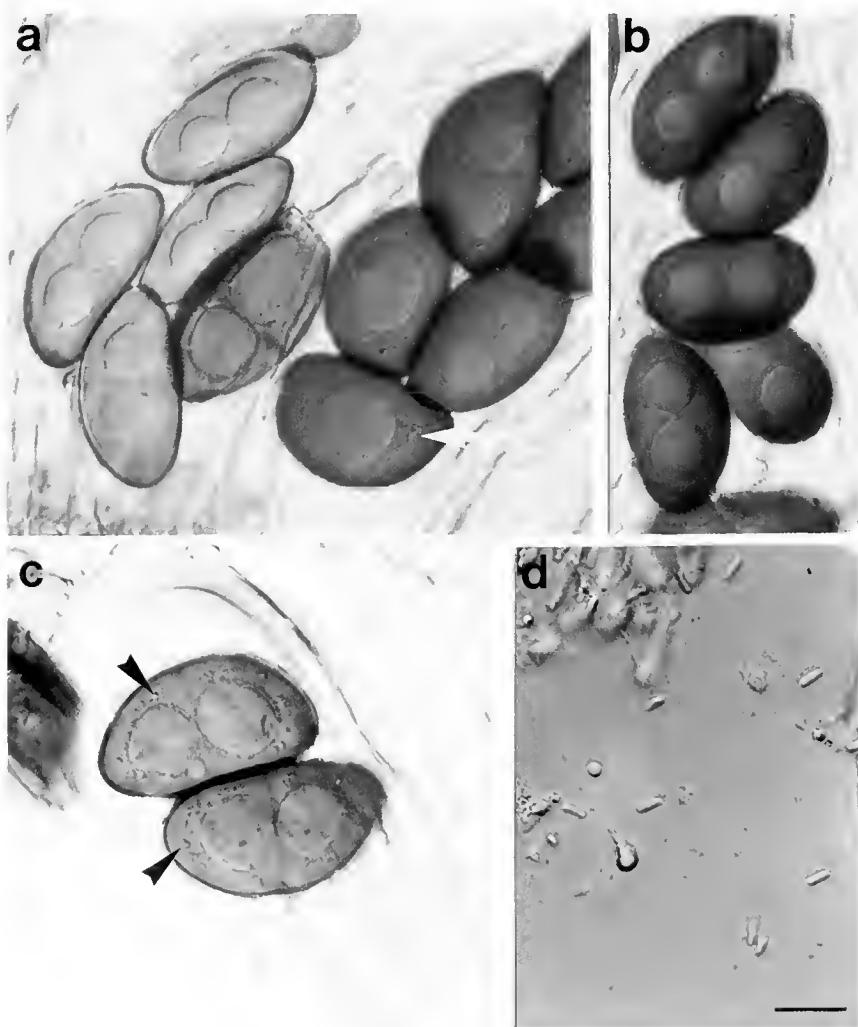
*Ecology and distribution:* *Rinodina conradii* is a widespread temperate species occurring throughout the boreal zone of northern Europe and in the Alps, in western North America, South America including the high mountainous regions in the tropics, and the Himalayan mountains (Krenn 1994, Mayrhofer & Krenn, in prep.). It was reported from Tasmania by Mayrhofer (1984b), and from New Zealand by Nylander (1888, as *Lecanora pyreniospora* var. *paupercula*), Hellbom (1896, as *Rinodina conradii* var. *sepincola*) and Mayrhofer (1985).

The species occurs on a wide range of substrates including plant debris, mosses, lichens, lignum, bark, thatch, the faeces of sheep and rabbits, and peat (Krenn 1994). Only those specimens growing on bark and lignum are listed below. In Tasmania, the species overgrows terricolous bryophytes and dead grasses in rough pasture.

*Specimens examined:* AUSTRALIA, WESTERN AUSTRALIA: Walpole National Park, 2 km SW of Walpole, along Rest Point Road, L. Tibell 14099, 12.x.1983 (GZU, PERTH, UPS); Busselton, Layman Road, near Wonnerup House, N. Sammy, 31.xii.1981 (PERTH). NEW ZEALAND: Southland, Monowai River, 2 km E of Lake Monowai, A. Henssen & H. Mayrhofer 2175, 22.ix.1981 (GZU).

**5. *Rinodina dolichospora* Malme, Bihang K. Svenska Vet.-Akad. Handl. 28 (III/1): 30 (1902). Type:** Brazil, Matto Grosso, Santo Antonio, Morro Grande, ad truncum dejectum in silvula humidam, G.O. Malme 2159, 20.xii.1893 (lectotype, here designated, S!). *Paratypes:* Brazil: Rio de Janeiro, Corcovado, Paneiras, G.O. Malme 344, 4.ix.1892 (S!); Rio Grande do Sul, Porto Alegre, G.O. Malme 663, 5.xi.1892 (S!); Rio Grande do Sul, excolonia Silveirae Martins pr. Santa Maria, G.O. Malme 1209B, 20.iii.1893 (S!).

*Thallus* crustose, thin and effuse or, more typically, rather thick, areolate to subsquamulose, pale olive-grey to olive brownish; areoles contiguous and fusing to discrete and ± dispersed, c. 0.3–1 mm wide, flat, convex or concave with ascending margins, at times somewhat microphylline or lobulate; prothallus black, thin, sometimes evident between the areoles. *Photobiont cells* 7–9 × 6–7 µm. *Chemistry:* no lichen substances detected by t.l.c.



**Fig. 10.** *Rinodina dolichospora* (a, b, d Thor 4827, c lectotype). a-c immature and mature ascospores with minute, scattered, globular, droplet like inclusions within the spore wall (arrow); d bacilliform spermatia. Scale: 10  $\mu\text{m}$ .

*Apothecia* 0.2–0.8(–1) mm diam., scattered,  $\pm$  lecanorine, sessile. *Thalline margin* well developed, occasionally  $\pm$  coronate, or incomplete and only partially enveloping a distinct pale brown to brown proper margin; cortex to 30  $\mu\text{m}$  thick, composed of globose hyphae, 4–5  $\mu\text{m}$  diam. *Disc* plane to undulate, rarely becoming convex, smooth, dark brown to blackish, matt. *Epiphymentum* 10–15  $\mu\text{m}$  tall, orange-brown to dark brown, unchanged in KOH. *Hymenium* hyaline, 100–130  $\mu\text{m}$  tall. *Hypothecium* 100–120  $\mu\text{m}$  deep, hyaline to pale yellowish. *Parathecium* well developed, up to 50–60  $\mu\text{m}$  thick at the upper edge, typically with a hyaline epinecral layer to 20  $\mu\text{m}$  thick. *Paraphyses* separating rather easily, simple or occasionally branched in the upper part, 1.5–2  $\mu\text{m}$  thick, with apices dark brown, capitate, 2–4  $\mu\text{m}$  wide; oil paraphyses absent. *Asci* eight-spored or reduced to six. *Ascospores* (Fig. 10) two-celled, of the *Pachysporaria*-type, occasionally one-celled, smooth-walled, dark brown, 24–30.5  $\times$  12.5–16  $\mu\text{m}$ , frequently with minute grain-like or droplet-like inclusions; torus indistinct; septum distinct only in mature ascospores; ontogeny of type A. *Spermogonidia* immersed, discernible as bulges in the

thallus surface, pierced by a minute, pale brown ostiole. *Spermatia* (Fig. 10d) bacilliform, 4.5–6 × 1.5 µm.

*Comments:* This represents the first record of *Rinodina dolichospora* from Australia. Our specimens accord closely with the type collections of Malme, which differ only very slightly in having ascospores within the range cited above but up to 33 µm long and a hymenium to 140 µm thick. In addition, the anatomical features of the apothecial margin are not as well developed in the type collection: the epinecral layer is only c. 5 µm thick and the cortex is only 5–10 µm thick. At least part of the type material appears to be from lignum.

Morphologically, *R. dolichospora* most closely resembles the other ± subsquamulose taxa, *R. australiensis*, *R. confusa* and *R. elixii*, and like these species, sometimes appears superficially like a small species of *Pannaria* or *Parmeliella*. In the case of *R. dolichospora* in particular, the apothecia are generally more sessile (rather than adnate to sunken), and their thalline margin may be rather coronate. Like *R. australiensis* and *R. elixii*, *R. dolichospora* also has large ascospores. *R. dolichospora* differs by having small photobiont cells, paraphyses which separate easily in squash mounts, and by lacking oil paraphyses. Another unique feature of the species is the presence of minute, scattered, globular inclusions within the spore wall.

The oceanic *Rinodina confinis* Samp. from south-western Europe may be a synonym of *R. dolichospora* (Giralt & Mayrhofer 1995, Giralt & Mayrhofer, in prep.).

*Ecology and distribution:* This species is known in Australia from two localities in coastal New South Wales, where it was recorded from the bark of *Casuarina cunninghamiana* and *C. glauca* in swamps and mangroves. Associated lichens include *Punctelia subflava*, *Rinodina asperata* and *Normandina pulchella*.

*Additional specimens examined:* NEW SOUTH WALES: Buckenbowra River, 7.5 km WNW of Batemans Bay, G. Thor 4827, 2.xi.1985 (S); same locality H. Streimann 35824 & J.A. Curnow (CANB); Red Rock, Corindi Creek, G. Kantvilas 129/98, 19.iv.1998 (GZU, HO).

## 6. *Rinodina elixii* H. Mayrhofer, Kantvilas & Ropin sp. nov.

Thallus crustosus, crassus, areolatus ad subsquamulosus, pallide olivaceo-griseus ad olivaceo-viridis; areolae contiguae et coalescentes, planae, firme adnatae, interdum aliquantum abrasae et lobulatae. Apothecia dispersa vel aggregata, lecanorina, primum thallo immersa, dcum per fissuris laceratis erumpentia, mature aliquantum impressa vel adnata vel sessilia. Hymenium in sectione longitudinali hyalinum, 130–150 µm altum; hypothecium 100–150 µm altum, hyalinum ad flavo-brunneum. Ascii 8-spori, interdum 4–6-spori. Ascosporae bicellulares, typo 'Physcia', fuscae, 23–30 × 12.5–16 µm, parietibus scaberulis, toro distincto. *Spermatia* bacilliformia, 4–5 × 1 µm.

*Type:* Victoria, Copi Flats, south side of Wyperfeld National Park, on *Callitris* sp., M. & H. Mayrhofer 4710, 18.viii.1981 (holotype GZU; isotypes UPS, HO).

*Thallus* crustose, thick and areolate to subsquamulose, pale olive-grey to olive-green; areoles contiguous and coalescing, mostly 0.2–0.5 mm wide, plane and tightly adnate, at times rather abraded and lobulate; prothallus absent. *Photobiont* cells 10–20 × (5–)9–15 µm. *Chemistry:* no lichen substances detected by t.l.c.

*Apothecia* 0.4–1 mm diam., scattered to crowded, occasionally overlapping, ± lecanorine, at first immersed in the thallus, soon emerging through ragged fissures, rather sunken, adnate or sessile when mature. *Thalline margin* ragged initially, derived from adhering thalline fragments, becoming ± smooth and entire, ultimately very thin to absent; proper margin very thin or inapparent, concolorous with the disc; cortex to 10–20 µm thick, composed of thickly packed, elongate hyphae. *Disc* plane or concave at first, becoming undulate to markedly convex, smooth to roughened, brownish black, matt. *Epiphytum* 10–20 µm tall, brown, unchanged in KOH. *Hymenium* hyaline,



Fig. 11. *Rinodina elixii* (holotype): mature ascospores; **c** and **d** are in different focus in order to show the minutely scabrid spore wall. Scale: 10  $\mu\text{m}$ .

130–150  $\mu\text{m}$  tall. *Hypothecium* 100–150  $\mu\text{m}$  deep, hyaline to yellow-brown. *Parathecium* rather well developed, pale brown, to c. 40  $\mu\text{m}$  thick with a hyaline epineural layer, 5–10  $\mu\text{m}$  thick. Paraphyses to 1.5  $\mu\text{m}$  thick, not separating easily, branched only in the upper part, with capitate, brown-pigmented apices, 3–5  $\mu\text{m}$  wide; oil paraphyses occasional, 5–6  $\mu\text{m}$  thick. Asci eight-spored, sometimes reduced to 4–6 spored. Ascospores (Fig. 11) two-celled, of the *Physcia*-type, dark brown, 23–30  $\times$  12.5–16  $\mu\text{m}$ ; wall minutely scabrid; torus distinct; septum distinct and persistent; ontogeny of type A. *Spermogonia* immersed in the thallus, with a hyaline wall and a slightly raised, brown ostiole. *Spermatia* bacilliform, 4–5  $\times$  1  $\mu\text{m}$ .

*Etymology:* This species is named in honour of our friend and colleague, Professor Jack Elix who has made outstanding contributions to lichenology in Australia.

*Comments:* *Rinodina elixii* is a very distinctive lichen, characterised by a thick, crustose to subsquamulose thallus, large *Physcia*-type ascospores and large photobiont cells. The spore wall is minutely scabrid, but this is generally observable only with a high quality light microscope. On the basis of thallus morphology alone, *R. elixii* is most closely related to *R. australieusis*, *R. confusa* and *R. dolichospora*. However, in well developed material, *R. elixii* tends to be recognisable by the distinctive ontogeny of the apothecia: these are formed in thalline warts which rupture and the apothecium emerges with thalline fragments adhering to its margin, rather like that described in some species of *Sarbanneana* by Kantvilas & Vězda (1996). These fragments fuse and abrade, and ultimately form a  $\pm$  complete, 'lecanorine' apothecial margin. A similar type of development is seen in *R. obscura*, which likewise has *Physcia*-type ascospores, albeit markedly smaller. However, this species differs further in having a very thin to almost absent crustose thallus and the thalline margin frequently becomes almost entirely excluded.

With respect to the size and type of ascospores and hypothecium characters, *R. elixii* is most closely related to the Arctic-alpine taxon *R. uniaraea* var. *uniaraea* which occurs almost exclusively on mosses and plant debris (Magnusson 1947, Timpe 1991, Mayrhofer *et al.*, in prep.).

*Ecology and distribution:* *Rinodina elixii* appears to be a rare species, known from only two localities in rather dry areas of south-eastern Australia, where it grew on the

lignum and bark of species of *Callitris* and *Brachychiton*. The specimens studied are associated with fragments of species of *Candelariella*, *Caloplaca* and *Flavoparmelia*.

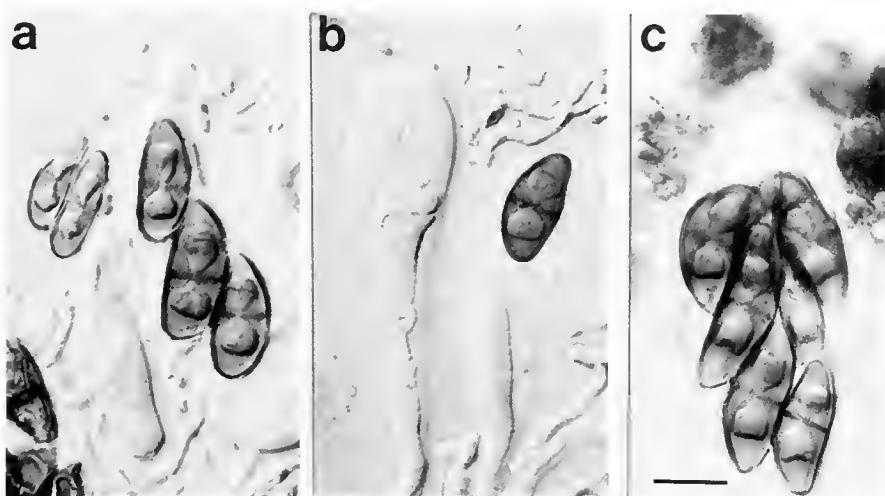
*Other specimen examined:* NEW SOUTH WALES: Cabonne, c. 5 km S of Molong, D., M. & H. Mayrhofer 8589, 12.viii.1988 (GZU).

**7. *Rinodina obscura* Müll. Arg., *Bull. Herb. Boissier* 1: 40 (1893). Type: Victoria, Oakleigh, F.R.M. Wilson 745, 1892 (holotype G!).**

*Thallus* crustose, very thin and effuse and almost inapparent to moderately thick and areolate, dingy olive-grey to olive-brown, rarely pale grey; areoles dispersed or contiguous, 0.1–0.3 mm wide; prothallus absent. *Photobiont* cells 7–9 × 6–8 µm. *Chemistry:* no lichen substances detected by t.l.c.

*Apothecia* 0.2–0.8(–1) mm diam., scattered, at first ± immersed in the thallus, soon emerging, sessile to adnate. *Thalline margin* at first ragged and ± incomplete, becoming smooth to rather abraded, increasingly excluded with age and often apparent only on the underside of the apothecium; proper margin very thin, black to dark brown, sometimes inapparent; cortex to 20 µm thick, composed of densely interwoven hyphae. *Disc* plane to undulate, occasionally convex, smooth to roughened, black, matt. *Epithymenium* 10–20 µm tall, dark brown, unchanged in KOH. *Hymenium* hyaline, 80–100 µm tall. *Hypothecium* hyaline to pale yellowish brown, (40–)80–150 µm deep. *Parathecium* very well developed, brown to yellowish brown, (25–)40–50 µm thick, with a hyaline epinecral layer to 5 µm thick. *Paraphyses* 1.5–2 µm thick, not separating easily, branched only in the upper part, with capitate, brown-pigmented apices 2.5–4 µm wide; oil paraphyses occasional, 6–7 µm thick. *Asci* eight-spored. *Ascospores* (Fig. 12) two-celled, of the *Physcia*-type, dark brown, 16–20 × 6–9 µm, smooth; torus distinct; septum persistent; ontogeny of type A. *Spermogonia* immersed in the thallus. *Spermatia* bacilliform, 3.5–4.5 × 1.5 µm.

*Comments:* With its *Physcia*-type ascospores, this species is related to *R. elixii*, differing mainly in that the latter has a much better developed, thicker, often subsquamulose thallus, larger ascospores with minutely roughened walls, larger photobiont cells and somewhat longer, more slender spermatia. Otherwise, many of the



**Fig. 12.** *Rinodina obscura* (a, b holotype; c Mayrhofer 4628): immature (a) and mature (b-c) ascospores with distinct torus. Scale: 10 µm.

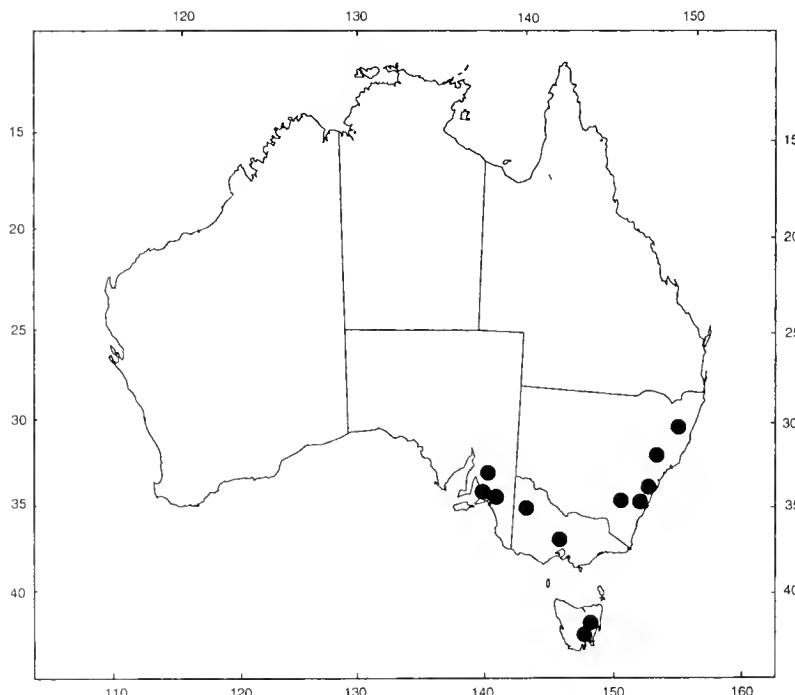


Fig. 13. Distribution of *Rinodina obscura*.

anatomical characters of these two taxa are identical and, furthermore, both display a similar type of development of the apothecia and their thalline margin (i.e. the apothecium emerges from the thallus with adhering thalline fragments that ultimately comprise the thalline margin). In *R. obscura*, this thalline margin finally becomes extremely reduced, to the point where the apothecia look lecideine and *Buellia*-like. Superficially, this species is somewhat similar to *R. asperata*, in that both have a rather thin, poorly developed thallus. However, the clearly lecanorine apothecia of the latter are distinctive and provide a valuable macroscopic aid to their separation. Whilst the dimensions of the ascospores and photobiont cells of these two taxa are similar, *R. asperata* differs in having *Paeltysporaria*-type ascospores.

*Rinodina obscura* differs from its closest European relatives, *R. septentrionalis* Malme and *R. ventricosa* Hinteregger & Giralt, by its darker thallus, by its apothecia which are not constricted at the base and have a thalline margin becoming increasingly excluded with age, and by a thicker hypothecium.

**Ecology and distribution:** *Rinodina obscura* is a species of low rainfall areas of southeastern Australia and eastern Tasmania (Fig. 13), where it occurs on rough, living or dead bark and on lignum in dry sclerophyll forest, mainly at low altitudes. Frequent host trees include species of *Allocasuarina*, *Eucalyptus* and *Acacia*. This lichen belongs to a very typical association of epiphytic dry woodland lichens, such as *Buellia* (*Hafellia*) *dissa*, *B. griseovirens*, *Candelariella xanthostigmoides*, *Pyrrhospora laeta*, *Rinodina asperata*, *Flavoparmelia rutidota*, *Parmelia conlabrosa* and species of *Caloplaca*, *Ramalina* and *Pertusaria*.

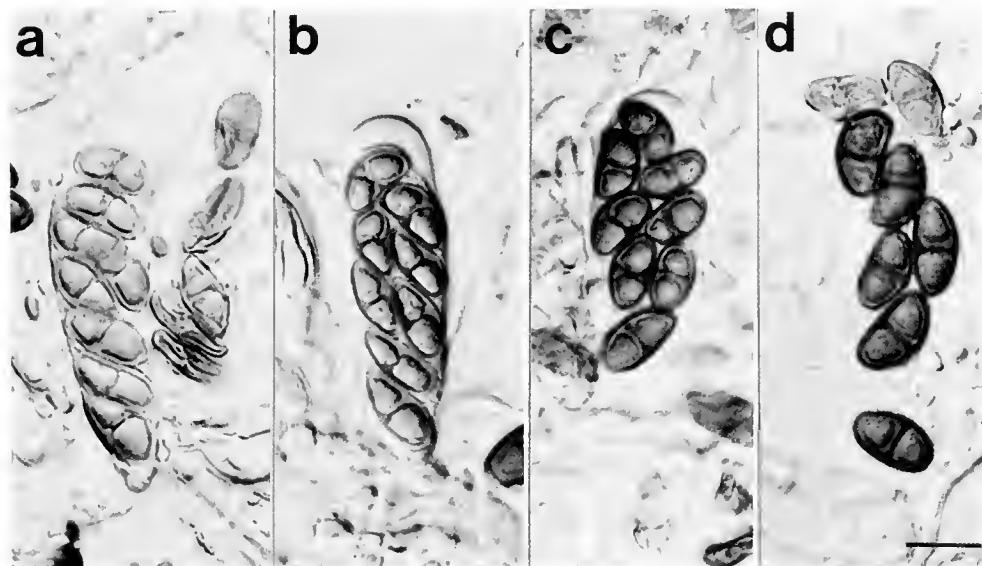
**Additional specimens examined:** SOUTH AUSTRALIA: about 5 km W of Oodla Wirra, *R.W. Rogers* 1625, 27.ii.1969 (BRI); Kuitpo Forest, 10 km E of Willunga, *M. & H. Mayrhofer* 4628, 14.viii.1981 (GZU); Kyeema Conservation Park, 21 km E of Willunga, *M. & H. Mayrhofer* 6675, 14.viii.1981

(GZU); summit of Mount Barker, 32 km SE of Adelaide, *M. & H. Mayrhofer* 2688, 11.viii.1981 (GZU). NEW SOUTH WALES: New England, Armidale Distr., Woilomombi Falls Reserve, E of Armidale, Edgars Lookout, c. 950 m, *H. Mayrhofer* 4650, 5384 & *J. Williams*, 12.x.1981 (GZU); 5525 (HO); same locality, *W.A. Weber & D. McVean*, 24.x.1967 (COLO); Bungonia Lookdown, rim of Shoalhaven River Gorge, 11 km E of Bungonia, *W.A. Weber & D. McVean*, 10.iv.1968 (COLO); Muswellbrook, between Sandy Hollow and Hollydeen, W of Muswellbrook, *D. M. & H. Mayrhofer* 8853, 14.viii.1988 (GZU, HO, Mayrhofer); Wanganderry Tableland, Lake Burratorang, near Wollondilly River, E of Byrnes Bay, SSW of 'The Oaks', *H. Mayrhofer* 4670a, 3.x.1981 (GZU); S of Boorowa River, NW of Yass, *D. M. & H. Mayrhofer* 8585, 11.viii.1988 (GZU). VICTORIA: Copi Flats, S side of Wyperfeld National Park, 125 km N of Horsham, *M. & H. Mayrhofer* 4624, 18.viii.1981 (GZU, MEL). TASMANIA: New Norfolk, *H. Mayrhofer* 12015, *E. Hierzer & G. Kantvilas*, 3.viii.1992 (GZU); 7 km E of Lake Leake, *G. Kantvilas*, 22.v.1996 (HO).

**8. *Rinodina pyrina* (Ach.) Arnold, *Flora* 64: 196 (1881); *Lichen pyrinus* Ach., *Lichenogr. Suec. Prodrom.*: 52 (1798). Type: without collector or locality (lectotype, *fide* Ropin & Mayrhofer 1993, BM-ACH!).**

*Thallus* crustose, rather thin and effuse, to moderately thick and areolate, often scabrid and mealy, pale grey to dingy olive-grey; areoles typically minute, somewhat dispersed and discontinuous, especially at the margins, contiguous in the centre of the thallus, plane to convex to  $\pm$  bullate; prothallus absent. *Photobiont* cells 16–22  $\times$  14–20  $\mu\text{m}$ . *Chemistry*: no lichen substances detected by t.l.c.

*Apothecia* 0.1–0.6 mm diam., scattered, typically very numerous, lecanorine, sessile when mature but sometimes rather immersed when young. *Thalline margin* well developed, thin, entire, occasionally abraded, persistent even in old apothecia; cortex indistinct, 5–10  $\mu\text{m}$  thick, composed of interwoven hyphae. *Disc* plane, occasionally becoming convex, brown to black, matt, usually somewhat scabrid. *Epilhymenium* 5–10  $\mu\text{m}$  tall, brown to dark brown, unchanged in KOH. *Hymenium* hyaline, 60–70  $\mu\text{m}$  tall. *Hypothecium* 50–60  $\mu\text{m}$  deep, hyaline. *Parathecium* poorly developed and rather indistinct, mostly c. 20–50  $\mu\text{m}$  thick. *Paraphyses* simple or branched occasionally near



**Fig. 14.** *Rinodina pyrina* (Kantvilas 209/89, GZU): **a** ascus with immature ascospores; **b-d** mature ascospores. Scale: 10  $\mu\text{m}$ .

the apices, separating easily, 1.5–2 µm thick; apices dark brown, capitate, 4–6 µm wide; oil paraphyses not observed. Ascospores (Fig. 14) two-celled, of the *Physconia*-type, often slightly curved, with faint median thickenings but lacking distinct apical thickenings when mature, pale to dark brown, generally smooth-walled, 12–15(–17) × 5–7 µm; torus sometimes evident; septum distinct and persistent at maturity; ontogeny of type A. *Spermogonia* not seen. .

*Comments:* The above description is based solely on collections from the study area, but compares favourably in all salient features to other published accounts of material from Europe (see Giralt & Mayrhofer 1995, Ropin & Mayrhofer 1993). *Rinodina pyrina* is well characterised by its ascospores which, unlike those of any other taxon in this study, lack the wall thickenings that characterise most *Rinodina* species. Instead, at maturity, the ascospores lack any apical thickenings and the median thickenings at the septum are often so reduced that the ascospores appear *Buellia*- or *Physconia*-type in the traditional sense of, for example, Schidegger (1993). Although we report the ascospores as being smooth-walled, some were very minutely roughened, but not to the extent of *R. elixii* and thus not to a degree to be easily observed. Also quite distinctive are the very large photobiont cells, which have also been observed by previous workers (e.g. Magnusson 1947).

The relatively thin, small, crustose thallus of *R. pyrina*, and its persistently lecanorine apothecia make it superficially most similar to *R. asperata*, although even macroscopically, the two taxa differ by the somewhat more dingy olive thallus and larger apothecia of the latter. There are also quite distinctive ecological differences between the two.

*Ecology and distribution:* At present, this species is known in Australia almost exclusively from the trunks, branches and twigs of exotic trees and shrubs, for example, *Corylus*, *Ficus*, *Morus*, *Mahs*, *Populus*, *Salix* and *Fraxinus*, in gardens, pastures and along roadsides. The sole collection from a native host (*Bursaria spinosa*) was from a disturbed roadside in Tasmania. We can also confirm its occurrence in New Zealand, also on introduced hosts. It is frequently the first colonizer of the youngest twigs in such habitats. Associated lichens include species typical of exposed, often nutrient-enriched habitats, such as *Xanthoria parietina*, *Physcia adscendens*, *Pnnctelia subundecta*, *Flavoparmelia rutidota* and species of *Caloplaca* and *Lecanora*. In our experience, *R. pyrina* is unknown in native vegetation (where it is essentially replaced by *R. asperata*) and thus there is a strong possibility that it has been introduced together with its hosts. The same may also be true of its cosmopolitan associate, *X. parietina*.

*Specimens examined:* SOUTH AUSTRALIA: Eudunda to Morgan Road, 6 km E of Mount Mary, M. & H. Mayrhofer 2718, 2741, 13.viii.1981 (GZU). AUSTRALIAN CAPITAL TERRITORY: Hawker, 10 km NW of Canberra, H. Streimann 10358, 22.vi.1980 (CANB). TASMANIA: Hobart, The Cascades, G. Kantvilas 208/89, 209/89, 13.viii.1989 (GZU, HO); Hobart, Mt Stuart Road, G. Kantvilas 735/84, x.1984 (HO); Constitution Hill, G.C. Bratt & M. H. Bratt 3106 (HO); Tunbridge, G. Kantvilas 158/98, 9.ix.1998 (HO). NEW ZEALAND: Canterbury, Canterbury Plains, Bankside Scientific Reserve, SE of Bankside, H. Mayrhofer 9016, 9021, H. Hertel, C.D. Meurk & B.P.J. Molloy, 14.i.1985 (GZU); Otago, Alexandra, Little Valley Road, 6 km from Alexandra, H. Mayrhofer 9720, H. Hertel & P. Child, 2.ii.1985 (GZU); Otago, Fruitlands, 12 km S of Alexandra, 460 m, V. Wirth 28539 & C.D. Meurk, 6.xi.1981 (STU).

### Excluded Taxa

*Rinodina archaea* (Ach.) Arnold. This species has been cited in numerous checklists for Australia (Filson 1983, 1986, 1987, 1988, 1996; McCarthy 1991) but does not appear to be substantiated by any specimens.

*Rinodina colobinoides* (Nyl.) Zahlbr. The record of Müller (1893a) refers to *Rinodina australiensis* (see above).

***Rinodina exigua*** (Ach.) Gray. The records of Shirley (1889) as *Lecanora exigua* from Queensland, and Jatta (1911) from Tasmania remain doubtful, because we have not been able to examine the cited specimens.

***Rinodina glomerella*** (Stirt.) Zahlbr. This species was described from Queensland (Bailey 1899). According to the protologue it belongs to *Buellia*.

***Amandinea insperata*** (Nyl.) H. Mayrhofer & Ropin comb. nov.; *Lecauora insperata* Nyl., Lich. Nov. Granat. I: 443 (1863). *Type*: [South America, Colombia] Nova Granata, Bogota: A. Liudig 2616, 1860 (lectotype, *fide* Aptroot 1987, H-NYL 28494!; isolectotypes H-NYL 28493!, H-NYL p.m. 2902!, 2903!, 9541); *Lecidea insperata* (Nyl.) Nyl., Flora 63: 128 (1880); *Rinodina insperata* (Nyl.) Malme, Bihang K. Svenska Vet.-Akad. Handl. 28(III/1): 44 (1902).

*Rinodina propior* (Nyl.) Müll. Arg., Bull. Herb. Boissier 2, App. I: 52 (1894); *Lecauora propior* Nyl., Lich. Nov. Zel.: 60 (1888). *Type*: New Zealand, no further details, C. Knight, 1868 (holotype H-NYL 30049!).

*Thallus* crustose, smooth and thin or rather thick, rimose-areolate or verrucose, sordid whitish, light brown to light grey; prothallus absent. *Photobiont* cells 12–16 × 10–14 µm. *Chemistry*: no lichen substances detected by t.l.c.

*Apothecia* 0.4–0.5 mm diam., scattered or crowded, lecanorine at first, becoming biatorine and finally lecideine, immersed to adnate. *Thalline margin* initially prominent and concolorous with the thallus, soon reduced; cortex indistinct. *Disc* plane to convex, black, matt. *Epiphyllum* to 10 µm tall, reddish brown to dark brown, unchanged in KOH. *Hymenium* 70–90 µm tall, hyaline. *Hypothecium* 50–70 µm deep, dark brown. *Paraphyses* simple or branched, 1–1.5 µm thick, with apices pigmented reddish brown to dark brown, 4–8 µm wide. *Asci* clavate, corresponding to the *Bacidia*-type (Rambold *et al.* 1994), eight-spored. *Ascospores* (Fig. 15) two-celled, of the *Orcularia*-type, pale-yellowish to pale brown, 14–19 × 6–8 µm, smooth; torus absent; septum indistinct; ontogeny of type A. *Spermatia* immersed. *Spermatia* filiform, 25–30 × 1 µm.

Comment: *Amandinea insperata* is characterised by the variable apothecia, *Orcularia*-type ascospores, the *Bacidia*-type asci, the brown hypothecium and the filiform spermatia. It is well separated from *Rinodina* (where it has been informally

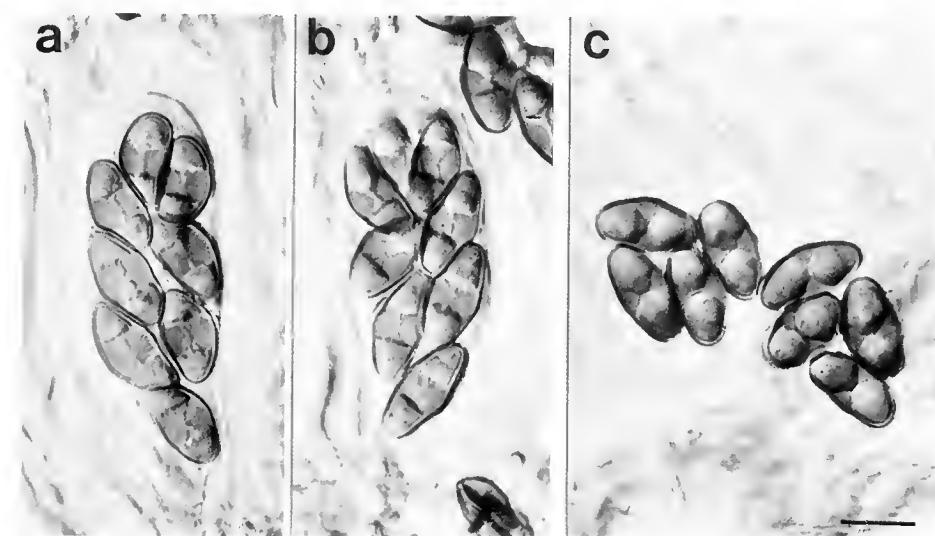


Fig. 15. *Amandinea insperata* (Wilson, 1890, G); a–b immature ascospores; c mature ascospores. Scale: 10 µm.

included at times) by the different ascus-type and the filiform spermatia. These characters place this remarkable species in the genus *Amandinea* M. Choisy ex Scheid. & H. Mayrhofer, which was reinstated by Scheidegger (1993).

*Ecology and distribution:* *Amandinea insperata* is known from several older herbarium collections from introduced trees in Victoria. More recent records from southern Queensland are from *Avicennia*. The Tasmanian record is from the bark of a coastal, wind-swept *Allocasuarina verticillata*, where it was associated with *Teloschistes chrysophthalmus*, *Rinodina australiensis*, *R. asperata* and species of *Buellia*. *Amandinea insperata* is also known from New Zealand.

*Selected specimens examined:* QUEENSLAND: Brisbane, Boondall, Sandgate Road/Brown Street, C. Scarlett & N. Stevens, 4.ix.1975 (BRI); Fraser Island, 1 km S of Eurong Beach, J. A. Elix 22909, 5.vii.1989 (CANB). VICTORIA: Kew, F.R.M. Wilson, iii.1896 (UPS); Malvern, F.R.M. Wilson 690, 9.viii.1886, 1890 (G); C. Knight 219, 223, 1887 (G). TASMANIA: Cape Contrariety, G. Kantvilas 185/98, 25.ix.1998 (HO). NEW ZEALAND: Nelson, Golden Bay, E of Takaka, H. Mayrhofer 12024, 12025, 28.viii.1992 (GZU).

*Rinodina metabolica* (Ach.) Anzi. Müller (1893a) lists three specimens from Victoria collected by Wilson. The specimen from Maffra (Wilson 698) refers to *Rinodina asperata*, the specimen from Camperdown (Wilson 694) remains enigmatic and is provisionally included in *R. asperata* (see comments under *R. asperata*), whilst the specimen from Malvern (Wilson 690) refers to *Amandinea insperata* (see above).

*Rinodina metabolica* var. *phaeocarpa* Müll. Arg. The record of Müller (1893a) from Victoria refers to *Amandinea insperata*.

*Rinodina placomorpha* (Stirt.) Zahlbr. This species was described from Queensland (Bailey 1899). According to the protologue it belongs to *Buellia*.

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## ***Leptecophylla*, a New Genus for Species Formerly Included in *Cyathodes* (Epacridaceae)**

*C. M. Weiller*

Bioinformatics Laboratory, Research School of Biological Sciences, The Australian National University, Canberra A.C.T. 0200, Australia.

### **Abstract**

The genus *Leptecophylla* C.M.Weiller is proposed to include 12 species, previously included in *Cyathodes* Labill., occurring in Australia, New Zealand, and several Pacific Island groups and for one species in New Guinea previously included in *Styphelia* Sm. New combinations made are: *L. divaricata* (J.D.Hook.) C.M.Weiller, *L. pendulosa* (S.J. Jarman) C.M.Weiller, *L. abietina* (Labill.) C.M.Weiller, *L. juniperina* (J.R.Forst. & G.Forst.) C.M.Weiller, *L. robusta* (J.D.Hook.) C.M.Weiller, *L. brassii* (Sleum.) C.M.Weiller, *L. imbricata* (Stschegl.) C.M.Weiller, *L. taeniameiae* (Cham. & Schltdl.) C.M.Weiller, *L. rapae* (Sleum.) C.M.Weiller, *L. brevistyla* (J.W.Moore) C.M.Weiller, *L. pomarae* (A.Gray) C.M.Weiller, and *L. mariannensis* (Kaneh.) C.M.Weiller. One new species, *L. pogonocalyx* C.M.Weiller, is described and three subspecies within *L. juniperina* are recognised. A key and descriptions are provided for the Australian and New Zealand species.

### **Introduction**

The genus *Leptecophylla* is described to include 12 species formerly included in *Cyathodes* and one in *Styphelia*. These species were referred to as the 'juniperina group' in a paper reassessing the generic limits of *Cyathodes* Labill. (Weiller 1996). Leaf arrangement and morphology and flower morphology provide the main characters distinguishing *Leptecophylla* from *Cyathodes* s. str. In *Leptecophylla* the leaves are alternate, usually small and pungent-tipped and have an appressed petiole; the flowers have short spreading corolla lobes and included or half-exserted anthers attached to filiform filaments, and the ovary is typically 5-celled; all species are apparently functionally dioecious. In *Cyathodes* s. str. the leaves occur in pseudowhorls and are longer and broader with a blunt tip and spreading petiole; the flowers have long, revolute corolla lobes and anthers fully exserted on thick filaments, the ovary is usually 6–10-celled and all species are hermaphrodite (see Table 1, Weiller 1996).

The relationships of *Leptecophylla* to other genera in the tribe Stypheliae are not resolved in recent morphological analyses (Powell *et al.* 1997) and results from molecular work for the tribe are not yet published. It is worth noting that of the species included in the *Cyathodes* A group of Powell *et al.* (1997), two belong to *Cyathodes* s. str. (*C. glauca* and *C. straminea*) and the rest to *Leptecophylla*. However the data matrix presented in Table 2 of the paper is applicable to *Leptecophylla* as notable features of *Cyathodes* s. str. are not scored as present, *viz.* long filaments with fully exserted anthers (character 7), filaments thick and tapering (11), and distinctly revolute corolla lobes (30).

### **Materials**

This study is based on herbarium material at AK, BISH, BM, CANB, CBG, CHR, HO, K, MEL, NSW and WELT and field collections of all Australian species and focuses predominantly on the Australian and New Zealand species of the genus. All types and collections cited have been seen unless otherwise indicated. Photos of types from BM and FI will be lodged at HO.

## Taxonomy

### *Leptecophylla* C.M.Weiller, gen. nov.

Folia alterna, parallelinervia, subtus glauca. Flores solitarii axillares, bracteolis subtendis multis et braeteis binatis carinatis basi. Sepala 5. Corolla quinqueloba; lobi patentes, aestivione valvata. Stamina 5, in fauce corollae inserta. Ovarium 5–7 loculare. Nectarium annulare vel lobatum. Drupa subsphaerica.

*Type species: Leptecophylla juniperina* (J.R.Forst & G.Forst.) C.M.Weiller

*Epacris* J.R.Forst. & G.Forst., *p.p.* in: Char. gen. pl. 19 (1776); G.Forst., Fl. ins. austr. 13 (1786).

*Archisia* Gaertn., Fruct. 2: 78, t. 94 fig. 2 (1791), *p.p.*, *nom. illeg.* non Sw. (1788).

*Styphelia* Sm., *p.p.* in: Labill., Nov. Holl. pl. 1: 48–49, t. 68–69 (1805); Poir., Encycl. 7: 482 (1806); Spreng., Syst. veg. 1: 654–659 (1824) (no generic description); F.Muell., Fragm. 6: 50 (1867); F.Muell., Fragm. 8: 54 (1873).

*Cyathodes* Labill., *p.p.* in: R.Br., Prodr. 539 (1810); Roem. & Schult., Syst. veg. 4: 41–42 (1819); G.Don, Gen. hist. 3: 776 (1834); DC., Prodr. 7: 740 (1839); J.D.Hook., Fl. nov.-zel. 1: 163 (1853); J.D.Hook., Fl. Tasman. 244, t. 74 (1857); J.D.Hook., Handb. N. Zeal. fl. 176 (1864); Benth., Fl. austr. 4: 167 (1868); Benth. & J.D.Hook., Gen. pl. 2: 612 (1876); Rodway, Tasman. fl. 113 (1903); Cheeseman, Man. New Zealand fl. 410 (1906); Cheeseman, Man. New Zealand fl. 694 (1925); Allan, Fl. New Zealand 1: 514 (1961); W.M.Curtis, Stud. Fl. Tasman. 2: 425 (1963). *Styphelia* subg. *Cyathodes* (Labill.) Drude, *p.p.*: in Engl. & Prantl., Nat. Pflanzenfam. 4, 1: 78 (1889); Sleumer, Blumea 12: 155 (1963).

*Lissanthe* R.Br., *p.p.*: in Spreng., Syst. veg. 1: 659 (1824) (no generic description).

*Trochocarpa* R.Br., *p.p.*: in Spreng., Syst. veg. 1: 660 (1824) (no generic description).

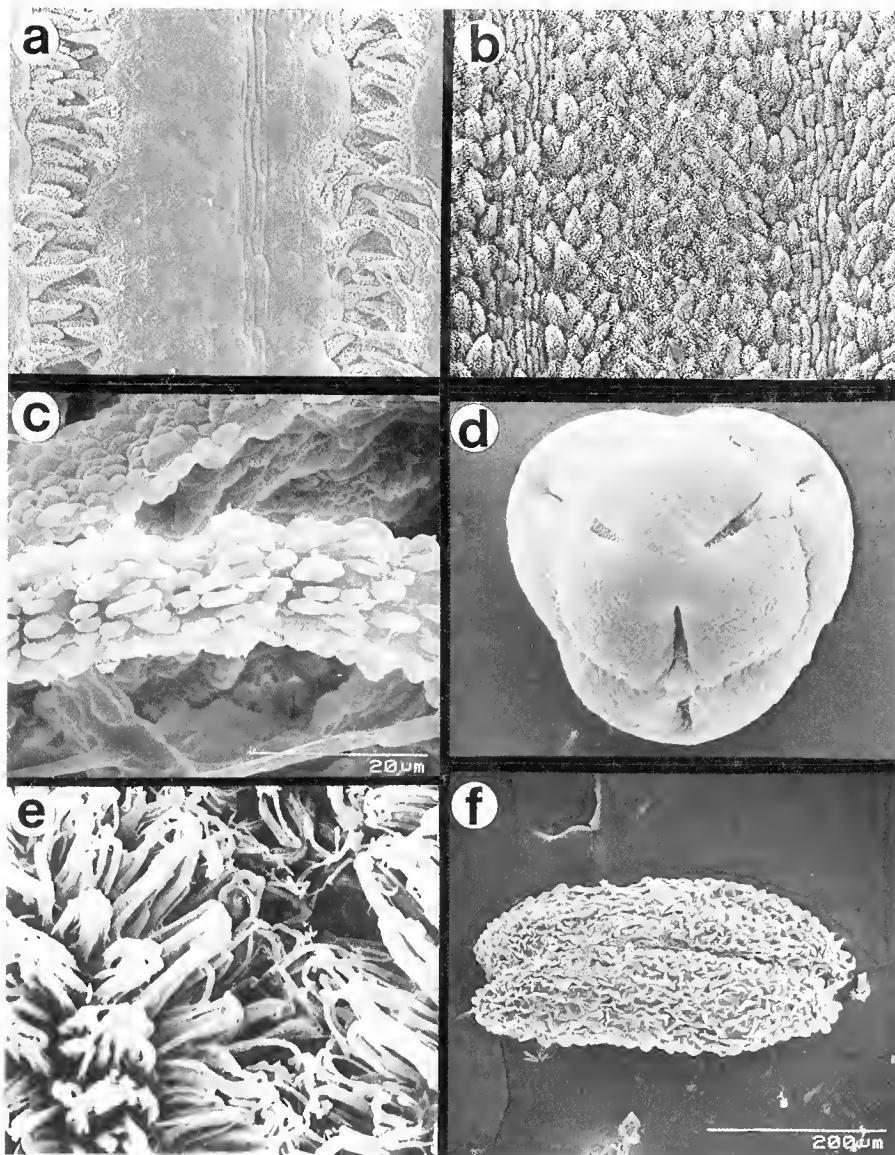
Low or erect usually compact shrubs to 2 m high, rarely a tree 6 m high. Stems glabrous, normally devoid of leaves, and with a rough, scaly, grey to brown bark. Leaves alternate, spreading or suberect, the lower surface glaucous and striate, the tip usually pungent. Inflorescence terminal and axillary. Flowers effectively unisexual (the plants dioecious), solitary in the leaf axils, subtended by paired, keeled bracts and numerous usually closely imbricate bracteoles, these cream to green, usually glabrous, and broadly ovate with a rounded obtuse apex. Sepals 5. Bracteole and sepal margins ciliolate. Corolla pentamerous, cream; tube campanulate or sub-urceolate, exceeding or about equalling the calyx, glabrous or pubescent inside; lobes valvate in bud, narrowly triangular, spreading, internally glabrous, with a few scattered hairs, or densely bearded. Stamens 5, alternating with the corolla lobes; filaments inserted at the top of the tube, short, the anther partially enclosed in the tube; anthers attached near the apex, linear. Ovary 5–7 celled with one ovule per cell; style attenuate from the ovary or inserted in a depression at the apex, short with the stigma at or below anther-level, or long with a conspicuous bend near the middle and the stigma exserted (*L. divaricata* and *L. pendulosa*), hollow with a pentaradiate canal and minutely papillose surface; stigma small, capitate or lobed; nectary annular and truncate, or lobed and toothed. Fruit a red, pink or white drupe, usually more or less spherical, the apex slightly flattened; the mesocarp thick and pulpy, the endocarp hard and bony; calyx and style persistent; retained on the plant into the next flowering season.

*Distribution:* Tasmania and Victoria in south-east Australia, New Zealand, Papua New Guinea and several Pacific Island groups.

*Etymology:* The name *Leptecophylla* has been arbitrarily formed from the Greek *lepteces*, fine-pointed and *phyllum*, leaf, alluding to the fine, pungent tip on the leaves of most species.

*Notes: Indumentum:* Young stems are either puberulent with sparse, short, white, hairs (*L. juniperina*, *L. divaricata*) or pubescent with dense, long, silky, white hairs (*L. pendulosa*). The adaxial leaf surface is either glabrous or has short hairs at the base of the leaf, occasionally extending up the midline. The abaxial leaf surface appears glabrous

in all species except *L. abietina*, which has short hairs lining shallow intervenal grooves (Fig. 1a). In the other species, papillae clearly visible only with SEM and in transverse section, cover the intervenal regions obscuring the stomata (Fig. 1b). The petiole is glabrous or has short hairs on the upper surface. In the majority of species the leaf margin is glabrous or shortly ciliolate only toward the apex, but in three species, *L. pendulosa*, *L. divaricata* and *L. imbricata*, it is usually entirely ciliolate.



**Fig. 1.** **a** Short trichomes coated in ribbon wax and lining intervenal grooves in *L. abietina*, R.K. Crowden 8410-06. Scale bar = 0.1 mm; **b** Intervenal papillae and veinal areas covered in ribbon wax in *L. juniperina* subsp. *juniperina*, R.K. Crowden 8301-04. Scale bar = 0.1 mm; **c** Corolla lobe hair from *L. abietina*, R.K. Crowden 8410-06; **d** Polar view of pollen tetrad of *L. juniperina* subsp. *parvifolia*, C.M. Mihaich 7; **e** Ribbon wax of *L. juniperina* subsp. *juniperina*, R.K. Crowden 8301-04. Scale bar = 10  $\mu$ m; **f** Aborted (female) anther of *L. divaricata*, F.H. Long 366.

*Corolla hairs*, when present, are usually confined to the inner surface where they vary in length, distribution, density and appearance. Scattered, translucent hairs regularly occur in *L. divaricata* and occasionally in *L. juniperita*, and are flattened with occasional, small, linear tubercles. The dense, white, woolly lobe hairs of *L. abietina* are rounder and the surface sculpturing more prominent (Fig. 1c).

*Leaves and bracts*: The simple leaves are alternate, separated by short internodes, and in most species the petiole is appressed to the stem. The lamina are usually spreading, although erect in *L. inubricata*, or rarely reflexed, entire, oblong to ovate and 2.5–20 mm long and flat or slightly convex with the margin sometimes recurved. The leaves are homoblastic, although occasionally the first-formed leaves tend to be obovate and the margin of the distal part of the leaf hyaline or scarious. The leaves of most species have a pungent tip although in several the tip is a callus or mucro. The upper surface of the blade is green, the lower surface glaucous and striate with equally prominent parallel veins. The marginal veins in the upper half of the leaf are occasionally secondarily branched, the branching is particularly evident in broader leaved forms of *L. tameianiae*.

The bracts enclosing the vegetative shoots are sometimes retained but are inconspicuous and may be observed at the base of the branchlets.

*Pollen*: The pollen of a number of species has been examined (Smith-White 1955, Venkata-Rao 1961, Franks and Watson 1963, McGlone 1978; all as *Cyathodes*). Smith-White described two pollen types in *Cyathodes*: 'S' or monad in which only one grain of the tetrad develops (*L. juniperita* subsp. *parvifolia*) and 'T' or tetrad type (*L. inubricata* and *L. tameianiae*). McGlone modified the categories and reclassified several species as the segregating tetrad type ('A'). It is probable that the A-type is more widespread as *L. divaricata* and *L. juniperita* (Fig. 1d), previously reported as T-type (Venkata-Rao 1961) or S-type (Smith-White 1955), were found to form tetrads varying in the number of viable grains from 0 to 4 (Weiller, unpublished data).

*Leaf Anatomy*: The leaves of the majority of species are characterised by a thick adaxial cuticle (12–25 µm) overlying large usually heavily lignified epidermal cells. In *L. pendulosa* it is only 5 µm thick. The abaxial cuticle is usually much thinner in many species (2.5–10 µm) and the epidermal cells small and only slightly lignified. Cuticularised papillae or unicellular trichomes are differentiated by the intervenal epidermal cells in all species.

The stomates are found only on the abaxial lamina surface and have been recorded on the adaxial sepal surface in *L. robusta*, *L. juniperita* subsp. *parvifolia* and *L. tameianiae* (Watson 1962, all as *Cyathodes*). They occur in distinct intervenal bands with the longitudinal axis aligned parallel with the leaf margin and are positioned level with or slightly above neighbouring epidermal cells. The stomatal arrangement is anomocytic (Watson 1967).

Palisade mesophyll occurs in 1–4 layers depending on the species. The proportion of spongy mesophyll also varies between species and may be open with large intercellular air spaces or tightly packed.

An arc of fibres supports the vascular bundle usually only on the abaxial side although occasional lignified cells are present on the adaxial side of the bundle. A row of parenchyma cells occurs between the abaxial fibre arc and the phloem in most species although occasional lignified cells are present in several. Between the fibres and the abaxial epidermis there is a layer of cells, occasionally lignified, consistent with the "endodermal cells" reported in *Acrotriche* (Paterson 1962).

*Phytochemical Data*: The leaves in all species have a dense covering of erect ribbons (Fig. 1e) either covering the entire abaxial surface or confined to short trichomes in the stomatal regions (Weiller *et al.* 1994). Wax composition is dominated by triterpenes and *n*-alkanes and is reported from earlier studies (Mihaich 1989). The distribution of

anthocyanins in three species, *L. abietina*, *L. divaricata* and *L. juniperina* has been reported (Jarman 1975; Jarman and Crowdhen 1971, 1973, 1974; all as *Cyathodes*). Cyanidin-3-galactoside and cyanidin-3-arabinoside are both widespread within the species surveyed and indeed across the whole family. In *Leptecophylla* cyanidin-3-galactoside is the dominant pigment in all organs of the species examined. Work on leaf flavonoid bisulphate distribution is being undertaken by Dr. R.K. Crowdhen who has made relevant data available to me; the compounds are reported here as A and B.

*Breeding System:* All of the nine species examined in detail are 'functionally dioecious'. The term 'functionally dioecious' is used to refer to those species producing apparently hermaphrodite and male-sterile flowers on separate plants with only male-sterile flowers setting fruit; apparently functional gynoecia are present in 'hermaphrodite' flowers. In male-sterile plants the anthers (Fig. 1f) abort early in development, are very much reduced in size and barren of pollen.

Fruit on 'hermaphrodite' plants is rare and usually small and malformed in comparison to fruit produced on male-sterile plants. Preliminary *in vitro* and field pollination studies indicate that this floral form is self-sterile, and that a prezygotic incompatibility mechanism operates following selfing or cross pollination (Mihaich 1989). Functionally 'male' and male-sterile plants occur in approximately equal proportions in a population and, as with many other species exhibiting dioecy, the floral phenotypes differ in size with the 'male' flowers conspicuously larger. Protandry occurs in all species examined.

Pollinators are unknown for most species although numerous types of insects have been observed visiting the flowers of several species and the flower type, size, colour and structure is generally consistent with insect pollinated species (Faegri and Pijl 1979). A recent study however has shown *L. divaricata* to be ornithophilous (Higham 1994).

#### *Species relationships*

Five of the Australian and New Zealand species (*L. juniperina*, *L. pogonocalyx*, *L. pendulosa*, *L. divaricata* and *L. robusta*) form a natural grouping based on similarities of morphology and chemistry. *L. abietina* has the floral type and wax chemistry of the former species but lacks flavonoid bisulphates and exhibits a different wax distribution, with the ribbon wax confined to the stomatal regions. Phytochemical data for the New Guinea and Pacific island species has not been determined. Morphologically *L. brassii* and *L. rapae* appear closest to the Australian and New Zealand species.

#### **Key to Australian and New Zealand species**

1. Leaves sub-erect to spreading, tip short, blunt, veins > 5 ..... 2
2. Leaf flat; corolla tube 4–4.5 mm long, > calyx, densely pubescent .. *L. abietina*
2. Leaf margin recurved; corolla tube 1.7–2 mm long, ≈ calyx, glabrous... 5. *L. robusta*
1. Leaves spreading, tip pungent; veins 3–7 ..... 3
3. Style inserted in a depression at the apex of the ovary ..... 4
4. Corolla with long hairs inside, tube > 5.5 mm; leaves 9–12 mm long, margin recurved ..... 3. *L. divaricata*
4. Corolla glabrous, tube < 4.5 mm long; leaves 3.8–8 mm long; margin flat or slightly recurved ..... 4. *L. pendulosa*
3. Style attenuate from the apex of the ovary ..... 5
5. Corolla glabrous or sparsely hairy, > calyx; calyx glabrous; leaf margin flat or recurved ..... 1. *L. juniperina*
5. Corolla glabrous, < or = calyx; calyx puberulent; leaf margin flat ..... 2. *L. pogonocalyx*

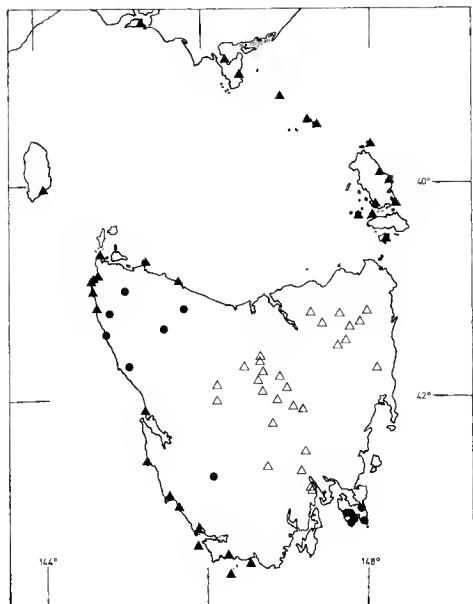
**1. *Leptecophylla juniperina* (J.R. Forst. & G. Forst.) C.M. Weiller, *couth. nov.* *Epacris juniperina* J.R. Forst. & G. Forst., *Char. gen. pl. 20, t. 10* (1776). *Type citation:* locality not designated, *Forster*. *Type:* not designated [New Zealand], part of G. Forster's Herbarium, *Forster* (lectotype here designated, BM). Two sheets, both Forster collections, are housed at BM. The material selected as the lectotype is mounted on a sheet bearing three handwritten labels – 'G. Forster's Herbarium', '71 ..... *juniiperina*' and 'β 126 *Stiphelia juniperina*'. Two specimens are on the sheet, the one on the right-hand side bears a single flower, the other is vegetative. The second sheet at BM with a single vegetative specimen comes from the Pallas Herbarium and has the labels – 'Herb. Pallas' and '*Stiphelia juniperina* a Col. Forster.' No locality information is present on the sheets or in the protologue, however subsequent authors such as Willdenow (1798) cite New Zealand. No Forster collections for the species were seen at K, although it is possible that specimens exist in other European herbaria such as LE and W. *Styphelia juniperina* (J.R. Forst. & G. Forst.) Willd., *Sp. pl. 1: 836* (1798). *Cyathodes juniperina* (J.R. Forst. & G. Forst.) Druee, *Rep. Bot. Exch. Cl. Brit. Isles suppl. 2: 618* (1917). *Cyathodes juniperina* (J.R. Forst. & G. Forst.) var. *juniiperina* Allan, *Fl. New Zealand 1: 516* (1961).**

*Epacris juniperina* sensu L. f., *Suppl. pl. 138* (1782); G. Forst., *Fl. ins. austr. 13* (1786). *Styphelia juniperina* sensu Pers., *Syn. pl. 1: 174* (1805); Poir., *Encycl. 7: 488* (1806). *Cyathodes juniperina* sensu W.M. Curtis, *Stud. Fl. Tasman. 2: 427* (1963); Willis, *Handb. Pl. Viet. 2: 508* (1973).

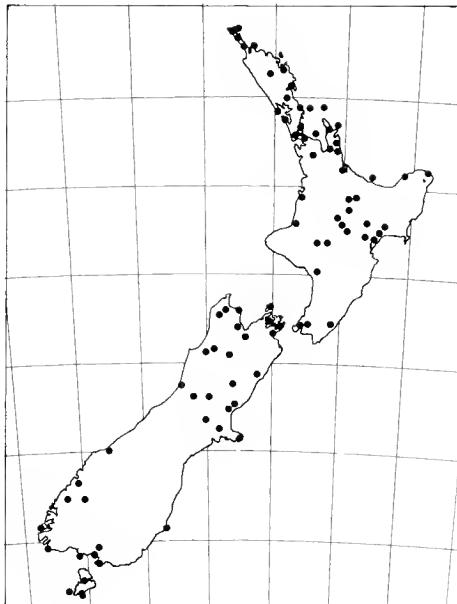
Dioecious, compact or tall shrubs 40–200 cm high, rarely trees to 6 m. *Stems* grey, brown or grey-brown; *brauchlets* usually brown but occasionally yellow-brown or red-brown, rounded, scabrous or puberulent. *Leaves* spreading or occasionally reflexed, narrowly ovate, 4.2–18 mm long, 1.1–2.5 mm wide, apex acute, tip pungent 0.4–1.6 mm long; margin flat or recurved, glabrous or ciliolate only toward the apex; upper surface glabrous or puberulent at base, lower surface with intervenal papillae and 3–7 veins; *petiole* erect, 0.6–1.7 mm long, appressed to stem, glabrous or puberulent on the upper surface. *Flowers* solitary, terminal and axillary on erect or recurved pedicels 2–5 mm long (male), 1.3–3 mm long (female); *bracts* ovate, 0.5–0.9 mm long, 0.6–1(–1.4) mm wide, obtuse, glabrous, margin usually ciliolate at apex; *bracteoles* and *sepals* ovate or elliptic, obtuse, glabrous; bracteoles 8–24 per flower, imbricate, 1.2–2.4 mm long, 1.1–2 mm wide; sepals 1.7–3.1 mm long, 1.1–2.3 mm wide. *Corolla tube* campanulate, exceeding the calyx, 2.1–4.4 mm long (male), 1.6–2.8 mm long (female), glabrous or with short, sparse hairs inside; *lobes* shorter than tube, 1.1–2.3 mm long, apex acute, glabrous or with short, sparse hairs. *Anthers* of male flowers 1.1–2 mm long, half-exserted; *filaments* 0.2–0.5 mm long, slightly exserted and visible between the lobes. *Ovary* more or less spherical 0.5–1 mm high, 0.6–1.3 mm wide, glabrous, (4–)5(–6) celled; *style* straight, glabrous, attenuate from the ovary, 1–1.8 mm long (male), 0.9–1.5 mm long (female); *stigma* 0.1–0.2 mm high; *nectary* 0.3–0.7 mm high, of distinct scales or weakly adherent scales separating with pressure, margin toothed or rounded and occasionally with hairs. *Drupe* white or pale to dark pink, slightly flattened sphere 4–7 mm high, 5–9 mm wide, 1–5 locules with ovules developing into seeds.

*Distribution and Habitat:* Widespread and variable species occurring throughout Tasmania, the Bass Strait Islands, the southern coastal regions of Victoria and throughout New Zealand, from extreme coastal to sub-alpine habitats (Figs. 2, 3).

*Leaf Anatomy:* The leaf is 330–370  $\mu\text{m}$  thick although thicker in *L. juniperina* subsp. *oxycedrus* (450–550  $\mu\text{m}$ ) with the adaxial cuticle 10–15  $\mu\text{m}$  and the abaxial cuticle 2.5–5  $\mu\text{m}$  thick. Rounded papillae occur in the stomatal regions. Adaxial epidermal cells heavily lignified, 32.5–40  $\mu\text{m}$  long, 17.5–25  $\mu\text{m}$  wide; abaxial cells narrowly lignified, small, 12.5–17.5  $\mu\text{m}$  long, 8–15  $\mu\text{m}$  wide. Two to three rows of elongate palisade mesophyll cells 80–95  $\mu\text{m}$  long, 15–20  $\mu\text{m}$  wide (or c. 122  $\mu\text{m}$  long and 17  $\mu\text{m}$  wide in subsp. *oxycedrus*) are associated with a compact spongy mesophyll of rounded cells.



**Fig. 2.** Australian distribution of *Leptecophylla juniperina* subsp. *juniperina* ●, *L. juniperina* subsp. *parvifolia* △, and *L. juniperina* subsp. *oxycedrus* ▲.



**Fig. 3.** New Zealand distribution of *Leptecophylla juniperina* subsp. *juniperina*.

Fibres form an arc beneath the vascular bundle and a few fibre cells may also be present on the adaxial side. Endodermal cells usually remain unthickened.

*Chemical Data:* Ribbon wax covers the abaxial lamina and is composed mainly of triterpenes (70–76%) and alkanes (5–10%). Triterpenes  $\beta$ -amyrenone,  $\alpha$ -amyrenone,  $\alpha$ -amyrin, F and F1 are consistently present.

*Notes:* *Leptecophylla juniperina* is taxonomically the most difficult taxon in the genus due to sympatry of several closely related species, a relatively wide geographic distribution (Tasmania, Victoria and New Zealand), and a somewhat confused nomenclature.

In Australia three morphological entities have generally been recognised within what may be termed the "juniperina complex". By implication Hooker (1860) includes *C. juniperina* under *C. oxycedrus*, as does Mueller (1868), and distinguishes it from *C. parvifolia* on size of the shrub, leaf and corolla. Bentham (1868) conversely includes *C. oxycedrus* under *C. acerosa*, as does Rodway (1903), and gives the distribution as coastal Victoria, coastal areas of Tasmania and "other parts of the island" and New Zealand. Curtis (1963) is the first to use the name *Cyathodes juniperina* in the Australian literature and places both *C. oxycedrus* (Labill.) R.Br. and "*C. acerosa* auct. non *Ardisia acerosa* Gaertn." in synonymy. Willis (1973) follows this treatment and in a note equates the "Australian [presumably coastal Victorian] and southern New Zealand populations .... to the var. *oxycedrus* ..." distinguished by longer, wider leaves with longer pungent tips. The Australian literature includes *C. parvifolia* as a distinct species. In his treatment for the Chatham Islands Mueller (1864) includes *C. parvifolia*, *C. oxycedrus* and *C. divaricata* under *C. acerosa* (= *C. juniperina*).

Floristic treatments in New Zealand have generally recognized *Cyathodes acerosa* (Gaertn.) Roem. and *Cyathodes acerosa* var. *oxycedrus* (Labill.) Cheeseman (Kirk 1889; Cheeseman 1906, 1925; Allan 1961).

Examination of numerous specimens shows a coastal form restricted to Australia. This taxon corresponds to the protologue for *Styphelia oxycedrus* Labill. None of the New Zealand material that I have seen corresponds to the Australian coastal form which is distinguished by the short sparse hairs inside the corolla, and broader 5–7 nerved leaves – features described by Labillardière but neglected by subsequent authors who have placed emphasis on the unbranched leaf veins to differentiate it.

This treatment circumscribes *Leptecophylla juniperina* as a variable and widespread species ranging from coastal to highland areas of Tasmania and New Zealand and the southern coastal region of Victoria. *Cyathodes parvifolia* R. Br. and the coastal form *C. oxycedrus* (Labill.) R.Br. are given subspecific rank within *L. juniperina*. All three forms occur in Tasmania. The New Zealand material is much more uniform overall, varying mainly in lamina length and width, tip length, and distribution and length of marginal hairs. Broader leafed specimens exhibit a greater frequency in branching of the outer veins toward the margin in the upper portion of the leaf. There also seems to be a greater prevalence of white-fruiting plants in New Zealand. The occurrence of these characters is variable across the material examined and does not appear to warrant taxonomic distinction; only subsp. *juniperina* is recognised in New Zealand.

The subspecies are distinguished as follows:

Subspecies *juniperina* forms a shrub or tree up to 6 m tall, the leaves are variable in length ranging from 4–18 mm and are usually narrow, with a flat or slightly recurved usually glabrous margin. The corolla is glabrous, the tube is usually longer than the calyx or, in New Zealand material particularly, approximately equal to it.

Subspecies *parvifolia* is the highland form common on the Central Plateau, east and south-east regions of Tasmania. It is most similar to subsp. *juniperina* from which it differs in shrub and leaf size and a greater tendency to recurvature of the leaf margin. Floral characters are identical for the two forms.

Subspecies *oxycedrus* represents the coastal form of the south-east, west, north-west and Bass Strait islands of Tasmania, and the southern coastal region of Victoria. It is distinguished by the low, compact, rigid, windswept shrub; broader leaves and the regular presence of sparse, stiff hairs on the internal surface of the corolla. The corolla tube is longer than the calyx.

Chemical features of the leaf wax data also correlates with the morphological data. The wax chemistry of subsp. *juniperina* and subsp. *parvifolia* is identical in the components present and only slight quantitative differences are apparent, consistent with the intra-specific variation expected in such a wide ranging species (Mihaich 1989). *Leptecophylla juniperina* subsp. *oxycedrus* is also very similar, distinguished by the presence of primary alcohols in the wax which places it with *L. robusta*, previously considered a form of *L. juniperina* by Hooker (1853).

The distribution of flavonoid components shows a different relationship between the morphological forms. Two flavonoid bisulphates are present in leaf material from plants of subsp. *juniperina* and subsp. *oxycedrus* but only one consistently occurs in subsp. *parvifolia*.

### Key to subspecies

1. Corolla with sparse, rigid hairs; leaves 1.5–2.5 mm broad, veins 5–7 .....  
.....c. subsp. *oxycedrus*
1. Corolla glabrous; leaves 1–2.1 mm broad, veins 3–5 .....2
  2. Leaves 4.2–5.8 mm long, margin recurved, veins 3(–5).....b. subsp. *parvifolia*
  2. Leaves 4–18 mm long, margin flat, veins 5 .....a. subsp. *juniperina*

*Leptecophylla juniperina* subsp. *juniperina*. Type indicated above under *Leptecophylla juniperina*.

*Ardisia acerosa* Gaertn., Fruct. 2: 78, t. 94 (1790). *Type citation*: In insula van Diemen. *Cyathodes acerosa* (Gaertn.) Roem. & Schult., Syst. veg. 4: 473 (1819). *Lissanthe acerosa* (Gaertn.) Spreng., Syst. veg. 1: 660 (1824). *Styphelia acerosa* F.Muell., Fragm. 8: 54 (1873).

*Leucopogon forsteri* A.Rich.. Voy. Astrolabe 216 (1832), *nom. illeg.* as *Epacris juniperina* J.R.Forst. & G.Forst. is cited in synonymy.

*Cyathodes acerosa* var. *parvifolia* J.D.Hook., Fl. Nov.-zel. 1: 163 (1853). *Type citation*: Port Nicholson, Taupo Lake, etc., Colenso, etc.; Middle Island, Lyall; all n.v.

*Cyathodes acerosa* sensu G.Don, Gen. hist. 3: 776 (1834); A.Cunn., Ann. Nat. Hist. ser. 1, 2: 47 (1839); DC., Prodr. 7: 741 (1839); F.L.Raoul, Choix pl. Nouv.-Zél. 44 (1846); J.D.Hook., Fl. nov.-zel. 1: 163 (1853); J.D.Hook., Handb. N. Zeal. fl. 176 (1864); F.Muell., Veg. Chatham-Isl. 42 (1864); Benth., Fl. austral. 4: 170 (1869); T.Kirk, Forest fl. New Zealand 213, t. 108 (1889); Rodway, Tasman. fl. 114 (1903); Cheeseman, Man. New Zealand fl. 411 (1906); Cheeseman, Ill. New Zealand fl. 2: t. 124 (1914); Cheeseman, Man. New Zealand fl. 694 (1925).

*Styphelia acerosa* sensu Laing & Blackwell, Pl. New Zealand 330, t. 109 (1906).

Selected illustrations: Cheeseman, Ill. New Zealand fl. 2: t. 124 (1914); T.Kirk, Forest fl. New Zealand, t. 108 (1889) as *C. acerosa*; Laing & Blackwell, Pl. New Zealand 332, t. 109 (1906) as *Styphelia acerosa* (photo).

Leaves 4–18 mm long, 1–2.1 mm wide, margin typically flat, glabrous or ciliolate toward apex, veins 5. Corolla tube usually glabrous, 1.5–2.8 mm long (male).  $n=10$  (Venkata-Rao 1961),  $n=11$  ? in New Zealand material (Sands 1960).

*Distribution and Habitat*: *Leptecophylla juniperina* subsp. *juniperina* is widespread in lowland to montane forest and shrubland throughout New Zealand, and in lowland areas of Tasmania in the east, areas of the north-west and west on Jurassic dolerite or tertiary basalt based soils (Figs 2, 3).

*Flowering Period*: Sept.–May.

*Chemical Data*: Leaf flavonoid bisulphates A and B are present.

*Selected Specimens Examined*: AUSTRALIA. TASMANIA. Tasman Peninsula: Mt Koonya, A. Moscal 5258 (HO); Mt Raoul, P.A. Collier 21, July 1984 (HO); between Tornado Flats and Lunchtime Creek, A.M. Buchanan 3274 (HO); Balt Spur, S.J. Jarman 25 (HO, NSW), R.K. Crowden 8301-04; Eaglehawk Neck E of Lufra Hill, N.C. Ford, 28 Sept. 1950 (NSW). Other locations: Blue Top, R.K. Crowden 8310-11; Upper Natone forestry reserve, C.M. Mihaich 13; The Clump, Sandy Cape, A. Moscal 4666 (HO); Koyule, W.M. Curtis, 19 May 1947 (HO); Degraves Valley, R.C. Gunn, 11 Nov. 1839 (HO); Murchison Highway 7.7 km N of Waratah and Guilford Rds junction, A.M. Gray 280, 281 (HO); 5 km SE of Strathgordon on Gordon River Rd, J.R. Busby 27 (HO). NEW ZEALAND. NORTH ISLAND. Northland - Auckland District: Kerr Point North Cape, P. Hynes, 24 Aug. 1957 (AK); near tearooms, Waitiki Landing, R.C. Cooper, 25 Sept. 1969 (AK); Puketi Forest N of the Waikape Stream, P.J. Bellingham, 26 June 1984 (AK); Urapukapuka Island, Te Akeake Point, R.E. Beever, 11 Jan. 1980 (AK); Lake Kakupuarere, Poutoi, W.R.B. Oliver, 11 Oct. 1928 (WELT); 2 km SW of Waiwera, G. Straka 336, (AK); Huia Rickards Bush, K. Wood, 6 Aug. 1948 (AK); Mangawhai Hill, R.C. Cooper, 10 June 1966 (AK); Whatipu Road Summit, R. Cooper, 7 Apr. 1965 (AK); Mt William, Pokeno, R.O. Gardner 26 (CHR). Coromandel: Thames, D. Petrie, Sept. 1896 (WELT); Kopu - Hikua Road nr Stadia Creek, R.C. Cooper, 17 Apr. 1967 (AK); Milled bush 2 miles N of Tairua, R.C. Cooper, 18 Apr. 1967 (AK); Burma Road, Whangapoua, R.C. Cooper, 16 Sept. 1965 (AK). Volcanic Plateau District: Whanarua Bay, Bay of Plenty, A.P. Druce, Dec. 1967 (CHR); Lake Taupo nr Whakamoenga Cave, A. Leahy, 11 May 1975 (AK); Wairakei, D. Petrie, Dec. 1895 (WELT); Mt Ruapehu, W.R.B. Oliver, Dec. 1927 (WELT); Tukino track off Desert Road, P. Hynes, 23 Jan. 1968 (AK); Onitapu Desert, V.D. Zотов, 5 Apr. 1931 (CHR); Rainbow Mt, L.B. Moore, 20 Mar. 1930 (CHR); Near Wakapapaiti Stream, D. Petrie, Oct. 1922 (WELT); Waiotapu, W.R.B. Oliver, 13 Sept. 1920 (WELT); Pureora, J.K. Bartlett, 26 Nov. 1977 (CHR). Hawke Bay: Maungaharuru Range, A.P. Druce, Oct. 1974 (CHR); Bell Bird Bush,

*A.P. Druce*, Dec. 1972 (CHR); Panekiri, Waikaremoana, *W.R.B. Oliver*, 12 Dec. 1946 (WELT). Wellington Region: Wainuiomata Valley, *A.J. Healy*, 20 June 1937 (CHR); Tauherenikau Valley, *R.L. Oliver*, Aug. 1941 (WELT); Days Bay, *R. Masou*, 4 Oct. 1948 (CHR); Auro Road, Upper Hutt, *B.L. Enting*, 18 Jan. 1970 (WELT); Summit Rimutaka Range, *W.R.B. Oliver*, 8 Apr. 1951 (WELT). SOUTH ISLAND. Marlborough: Ship Cove Queen Charlotte Sound, *A.P. Druce*, 6 Dec. 1953; Red Hills, Wairau Valley, Marlborough, *L.B. Moore*, 19 Apr. 1965 (CHR); Minginningi, Picton, *J.H. McMahon* (WELT); Kenepura, *J.H. McMahon* (WELT); Resolution Bay, *L.B. Moore & J. Clarke*, 15 Oct. 1965 (CHR). Nelson: E of Parapara Peak, NW Nelson, *A.P. Druce*, Nov. 1975 (CHR); Mt Burnett, Wakamarama Range, *A.P. Druce*, Jan. 1982 (CHR); Matiri River, *A.P. Druce*, May 1977 (CHR); SE slopes of Mt Frederic, *P.G. Morgan*, 10 Feb. 1912 (WELT); Lake Rotoiti, *J.H. McMahon*, Nov. 1934 (WELT); Black Hill, *M.J.A. Simpson* 30 Oct. 1961 (CHR); Track to Falls River from Torrent Bay, *A. Lush*, Jan. 1951 (WELT); Lead Hills, *W.R.B. Oliver*, 24 Dec. 1946 (WELT). Canterbury - Westland - Otaga: Culverden Plain, *L. Cockayne*, 2 Nov. 1905 (WELT); Jacks Pass, *P. Hynes*, 28 Jan. 1965 (AK); Banks Peninsula Castle Rock, *P. Douglas*, 29 Sept. 1983 (CHR); NW of Kowai Bush, *B.H. Macmillan*, 30 Mar. 1970 (CHR); Otago Peninsula, Pudding Island, *P.N. Johnson*, 14 Feb. 1982 (CHR). Southland - Fiordland: Colac Bay, *L. Cockayne*, 16 Nov. 1905 (WELT); Bluff Hills, Southland, *L. Cockayne*, Oct. 1902 (WELT); Charles Sound Fiords, *W.F. Harris*, 28 Feb. 1949 (CHR); Poison Bay, *P. Wardler & A.F. Mark*, 10 Feb. 1974 (CHR); Head of Milford Sound, *W.R.B. Oliver*, 19 Dec. 1944 (WELT). Stewart Island: Mt Rakaehua, (WELT); Port Pegasus, *C. Black*, 22 Jan. 1955 (WELT); North Arm, *N.M. Adams*, 26 Feb. 1972 (WELT); Pryces Peak, *L. Cockayne*, 29 Sept. 1908 (WELT).

*Notes:* The combination *C. acerosa* was correctly made by Roemer & Schultes (1819) although it has often been ascribed to Robert Brown (1810), including by Roemer & Schultes. The name is based on the Banks & Solander manuscript name *Stiphelia acerosa* from collections made by them in New Zealand during Cook's first voyage to the area. Roemer & Schultes incorrectly give Tasmania as the locality but Cook's first voyage did not land in Tasmania. Two and probably three sheets with Banks and Solander specimens are at BM. One bears the citation 'In sylvis prope Opuragi, Totaranui', the second sheet has a typewritten label with the date '5th-15th Nov. 1769', at which time Cook was anchored in Mercury (now Cook) Bay, and a reference to 'Solander, Prim. Fl. N. Zeal. p. 437, Parkinson Ic. 120.' The specimens are vegetative or with a few fruit. There is little doubt that Gaertner based the name *Ardisia acerosa* on Solander's manuscript name *Stiphelia acerosa*, nor that subsequent authors did other than follow this concept. The Banks and Solander specimens of *Stiphelia acerosa* and the Forster specimens of *Epacris juniperina* at BM represent the same taxon.

*Leptecophylla juniperina* subsp. *parvifolia* (R.Br.) C.M.Weiller *comb. et stat. nov.* *Cyathodes parvifolia* R.Br., Prodr. 540 (1810). *Type citation:* [D] v.v. *Type:* 'Styphelia erythrocarpa, In lateribus .... Montis Tabularis ad Iluo: Derwent, Feb: - May 1804', R.Brown (Bennett No. 2416) (holotype BM, photo HO; isotype K). On the reverse of the handwritten label of the type is '4 *Cyathodes parvifolia* prodr. 540'. The typed label has the dates Feb. 18th, 19th, and 27th 1804. A second sheet with a single specimen bears the same typed label. Both bear the manuscript name *Styphelia erythrocarpa*. *Lissanthe parvifolia* (R.Br.) Spreng., Syst. veg. 1: 660 (1824). *Styphelia parvifolia* (R.Br.) F.Muell., Pap. Proc. Roy. Soc. Tas., 86 (1874). *Styphelia oxycedrus* Labill. var. *parvifolia* (R.Br.) Sleum., Blumea 12: 156 (1963).

*Cyathodes parvifolia* sensu Roem. & Schult., Syst. veg. 4: 472 (1819); G.Don, Gen. hist. 3: 776 (1834); DC., Prodr. 7: 741 (1839); J.D.Hook., Fl. Tasman. 246 (1857); Rodway, Tasman. fl. 115 (1903); W.M.Curtis, Stud. Fl. Tasman. 2: 428 (1963).

*Leptecophylla juniperina* subsp. *parvifolia* is the small leafed highland form, leaves 4.2–5.8 mm long, 1.4–1.7 mm wide, margin recurved, ciliolate toward apex, 3(–5) veined. Corolla tube glabrous, 2.1–3.5 mm long (male).  $2n=20$  (Smith-White 1955, as *Cyathodes parvifolia*).

*Distribution and Habitat:* Common at altitudes above 600 m in the central and eastern parts of Tasmania, on rocky dolerite slopes in open eucalypt forests and also on the lower Carboniferous-Devonian rock types in the north-east (Fig. 2).

*Flowering Period:* (Oct.-)Nov.-Dec.(-Jan.)

*Chemical Data:* Leaf flavonoid bisulphate A is present.

*Selected Specimens Examined:* AUSTRALIA. TASMANIA. Mt Wellington: Wellington Falls *L. Rodway* 146 (HO); *J.M. Powell* 504A (HO, NSW); Collinsvale Track, *W.M. Curtis*, 23 Dec. 1951 (HO); Collins Cap to Trestle Mountain Track, *A. Brown* 19 (HO); Mt Arthur towards Collinsvale, *F.H. Long* 1054 (HO). Mt Field: slopes above Lake Fenton, *N.T. Burbidge* 3278 (HO); near Lake Dobson huts, *J.M.B. Smith* 242 (HO); slopes of Mt Field East, *J. Vickery*, 17 Jan. 1962 (NSW). Central Plateau: 7 miles N of Breona, *J.H. Hemsley* 6300 (HO, NSW); Mienna, *A.T. Dobson* 77230 (HO); Pine Lake, *F. Duncan* 18 (HO); Alma Pass W of Interlaken, *J.M. Powell* 1628 (HO, NSW); Bradys Lookout summit, *A. Moscal* 630 (HO); Gorge-Jackeys Marsh Road, Meander, *J. Somerville*, 13 May 1962 (HO); Liawenee, *R.K. Crowden* 8310-09; Ironstone Bluff, *R.K. Crowden* 8310-08. Ben Lomond region: near road at top of Jacobs Ladder, *M.G. Noble* 28104 (HO); Mt Victoria, *M.G. Noble* 29209 (HO); NE slope of Mt Saddleback, *P. Collier*, 1 July 1984 (HO); S of Maurice Road, 500 m E of Wayback Hill, 20 km SSE of Scottsdale, *J.R. Busby* 101 (HO). Other locations: track up Mt Rufus c. 5 km W from Cynthia Bay camping area, Lake St Clair, *J.M. Powell* 1618 (HO); Poatina Highway, *M. Thompson* 24 (HO); Victoria Valley Road, *W.M. Curtis*, 24 Feb. 1983 (HO); Arthurs Lakes *R.C. Gunn*, 17 Nov. 1845 (HO); East Bagdad Road E of Long Tom, *A.M. Gray* 605 (HO); High Peak, *H.D. Gordon*, 1 Nov. 1937 (HO); Horseshoe Marsh St Pauls River, *A. Moscal* 286 (HO).

*Leptecophylla juniperina* subsp. *oxycedrus* (Labill.) C.M. Weiller comb. & stat. nov. *Styphelia oxycedrus* Labill., Nov. Holl. pl. 1: 49, t. 69 (1805). *Type citation:* 'in capite van Diemen, Labill.' (holotype FI-WEBB, seen in photo). *Cyathodes oxycedrus* (Labill.) R.Br., Prodr. 540 (1810). *Cyathodes acerosa* (Gaertn.) Roem. & Schult. var. *oxycedrus* (Labill.) Cheeseman, Man. New Zealand fl. 411 (1906). *Cyathodes juniperina* (J.R. Forst. & G. Forst.) Druce var. *oxycedrus* (Labill.) Allan, Fl. New Zealand 1: 516 (1961). *Styphelia oxycedrus* Labill. var. *oxycedrus* Sleum., Blumea 12: 155 (1963) in key. *Lissauthe oxycedrus* (Labill.) Spreng., Syst. veg. 1: 660 (1824).

*Styphelia oxycedrus* sensu Poir., Encycl. 7: 487 (1806); F. Muell., Fragm. 6: 43 (1867). *Cyathodes oxycedrus* sensu Roem. & Schult., Syst. veg. 4: 472 (1819); G. Don, Gen. hist. 3: 776 (1834); DC., Prodr. 7: 741 (1839); J. D. Hook., Fl. Tasman. 246 (1857). *Cyathodes acerosa* var. *oxycedrus* sensu Cheeseman, Man. New Zealand fl. 694 (1925).

Illustrations: Labill., Nov. Holl. pl. 1: t. 69 (1805).

*Leptecophylla juniperina* subsp. *oxycedrus* is a low, rigid shrub characterised by broader leaves, 7-12.4 mm long, 1.5-2.5 mm wide, with 5-7 veins, margin flat and entirely glabrous. Corolla tube 2.6-4.4 mm long (male) or 2.3-2.8 mm long (female), regularly with short, sparse, bristle-like hairs on the inner surface.

*Distribution and Habitat:* This form is restricted to the exposed, rocky, coastal regions of southern and western Tasmania, the Bass Strait Islands and southern Victoria, occurring on tertiary basalts and Pre-Cambrian metamorphic rock types (Fig. 2).

*Flowering Period:* (Aug.-)Sept.-Oct.(-Nov.)

*Chemical Data:* Leaf flavonoid bisulphates A and B are present.

*Notes:* Robert Brown (1810) noted the close similarity of *Styphelia* [*Cyathodes*] *oxycedrus* and *C. acerosa*.

*Selected Specimens Examined:* AUSTRALIA. VICTORIA: Cape Woolamai Phillip Island, 4 miles SE of automatic light, *A. Opie* & *S. Van Berkel* P.I. 27 (HO); Wilsons Promontory, *R.K. Crowden* 8508-204; Tongue Point, *J.H. Willis* 8 Nov. 1970 (MEL); Chinaman Long Beach, *P.C. Heyligers* 81030 (MEL). TASMANIA: West Point, *A. Moscal* 7735 (HO); Marrawah, *W.M. Curtis*, May 1948 (HO); Green Point, *W.D. Jackson*, Jan. 1958 (HO); Coxs Bight, *D.I. Morris* 8285 (HO); Sanctuary Bay, *A.M. Buchanan* 2613 (HO); Bond Bay, *M. Davis* 1260 (HO, MEL); Bluff Hill

Point, A. *Moscal* 7866 (HO); Nettley Bay, A. *Moscal* 7764 (HO); Nye Bay, R. *Buttermore* 005 (HO); Maatsuyker Island, A. *Moscal*, Nov. 1976 (HO), Aug. 1976 (HO); Macquarie Harbour, L. *Rodway*, Aug. 1891 (HO); Catamaran, H.F. *Comber* 2263 (HO); Woolnorth, R.C. *Gum*, 22 Sept. 1838 (HO, NSW); Recherche Bay, J.H. *Maiden*, Mar. 1908 (NSW). Bass Strait Islands: Grassy, King Island, W.M. *Curtis*, 29 Oct. 1976 (HO); Furneaux Group, East Sister Island, J.S. *Whinray* 276 (MEL); Deal Island, N.P. *Brothers* 407 (HO); Mt Chapell Is., J.S. *Whinray* 1138, 1162 (MEL); Dover Is., Myrinidon Bay, J.H. *Mullet*, Dec. 1966 (MEL); Mt Strzelecki Track, P. *Collier* 790 (HO); Rabbit Is., J. *Bovisto* (MEL); Doughboy Is., J.W. *Andas*, Dec. 1912; Kents Is., R. *Brown* (MEL).

## 2. *Leptecophylla pagonocalyx* C.M. Weiller sp. nov.

A *L. juniperina* (J.M. Forst. & G. Forst.) C.M. Weiller bracteolis et sepalis puberulis et corolla glabra tubo calycem aequanti vel breviori differt.

*Types*: From the eastern slopes above Lake Dove, Cradle Mountain–Lake St. Clair National Park, Tasmania, 21 Nov. 1985, C.M. *Mihaich* 5 (holotype HO).

Dioecious (?), compact or tall shrubs 50–200 cm high. Stems grey or grey-brown; branchlets yellow-brown or brown, rounded, puberulent or pubescent. Leaves evenly spaced, usually spreading or somewhat reflexed, narrowly ovate, 5.2–9.9 mm long, 1.2–1.9 mm wide, apex acute, tip pungent 0.4–1.2 mm long; margin flat or slightly recurved, glabrous or ciliolate only towards the apex; upper surface glabrous or puberulent at base; lower surface with intervenal papillae and 5 veins; petiole erect, 0.8–1.5 mm long, appressed to stem, glabrous or puberulent on the upper surface. Flowers (Fig. 4) solitary, terminal and axillary on usually erect pedicels 3–4 mm long (male), 1.7–2.4 mm long (female); bracts ovate, 0.5–0.8 mm long, 0.6–1 mm wide, obtuse, glabrous or puberulent at apex, margin glabrous or ciliolate at the apex; bracteoles and sepals ovate, broadly acute or obtuse, the apex occasionally with a short



Fig. 4. Air dried 'male' flower of *L. pagonocalyx* showing hairy calyx, and corolla tube about equalling the calyx, J.M. Powell 1539.

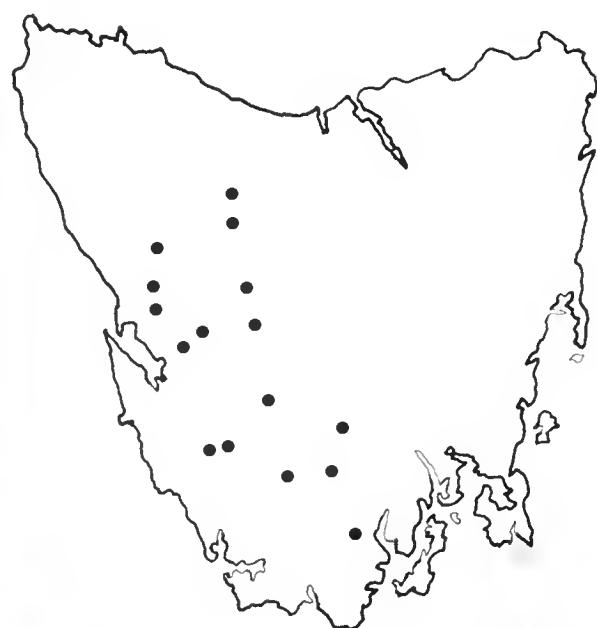


Fig. 5. Distribution of *Leptecophylla pagonocalyx*.

mucro, puberulent; bracteoles 10–22 per flower, imbricate, 1.6–2.7 mm long, 1.4–2 mm wide; sepals 2.1–3.1 mm long, 1.4–2.1 mm wide. *Corolla tube* campanulate, equal to or shorter than the calyx, 1.9–2.5 mm long (male), 1.6–2.4 mm long (female), glabrous; *lobes* shorter than tube, glabrous, 1.3–1.8 mm long, apex acute. *Anthers* of male flowers 0.8–1.6 mm long, enclosed or half-exserted; *filaments* 0.2–0.3 mm long. *Ovary* spherical, 0.6–1 mm high, 1–1.3 mm wide, glabrous, 4–6 celled; *style* straight, glabrous, attenuate from the ovary, 1.1–1.4 mm long (male), 0.9–1.3 mm long (female); *stigma* 0.1 mm high; *nectary* separating into distinct scales with pressure, or in distinct scales, 0.3–0.5 mm high, margin entire, toothed or rounded, glabrous or occasionally with hairs. *Drupe* pink, spherical, 3–5 mm high, 5–8 mm wide, 1–5 locules with ovules developing into seeds.

*Comments:* *Leptecophylla pagonocalyx* is distinguished from *L. juniperina* by the short corolla tube, which is equal to or shorter than the calyx in both floral forms and the puberulent calyx and bracteoles.

*Distribution and Habitat:* Confined to the western region of Tasmania, usually at altitudes above 600 m (Fig. 5).

*Etymology:* The epithet *pagonocalyx* refers to the densely puberulent calyx.

*Flowering Period:* Nov.–Dec.

*Leaf Anatomy:* The leaf is 360–370 µm thick with the adaxial cuticle 12.5–15 µm and the abaxial cuticle 2.5 µm thick. Rounded papillae occur in the stomatal regions. Adaxial epidermal cells heavily lignified, 32.5–37.5 µm long, 17.5–20 µm wide; abaxial cells narrowly lignified, small, 12.5–17.5 µm long, 12.5 µm wide. Three rows of elongate palisade mesophyll cells 95 µm long, 20 µm wide are associated with a very compact spongy mesophyll of rounded cells. Fibres form an arc beneath the vascular bundle and occasionally a cap on the adaxial side of the bundle. Endodermal cells remain unthickened.

*Chemical Data:* The triterpenes β-amyrin and 'N' are the major components in the leaf wax. Leaf flavonoid bisulphates A and B are present.

*Selected Specimens Examined:* AUSTRALIA. TASMANIA. Cradle Mountain - Lake St Clair National Park: near Lake Henson, 3 km NE of Cradle Mountain, 4 km SE of Waldheim, *J.R. Busby* 73 (HO); Labyrinth Track above Cephissus Creek (Pine Valley) about 2/3 of the way to the ridge crest, *J.R. Busby* 135 (HO); track to Marions Lookout, *J.M. Powell* 1539 (CANB, HO, NSW). Mt Field National Park: Platypus Tarn, *S.J. Forbes* 1282 (HO); by 2nd bend on road below Lake Fenton, *R. Melville* 2379, 2380 (HO, NSW). Hartz Mountain National Park: Track to Lake Osborne, 600 m ESE of the lake, *J.R. Busby* 1/4 (HO); Arve Road, *J. Somerville* (HO); junction of Hartz Hut track and Hartz Rd, *R. Filson* 10485 (MEL). Western Tasmania: S of Queenstown, *M.L. Westbrook*, 22 May 1938 (HO); Lake Margaret Track, *J. Somerville*, Mar. 1957 (HO); Rosebery, *W.M. Curtis*, 7 Dec. 1954 (HO); Lake Arthur, Western Arthur Range, *I. Olsen*, 7 Jan. 1967 (HO, NSW); Frenchmans Cap Range, *H.D. Gordon*, 14–15 Dec. 1944 (HO); Mt Sprent, *S.J. Jarman*, 10 Dec. 1978 (HO); NE ridge of Mt Anne, *A.M. Buchanan* 3719 (HO); King William Range, *E. Rodway* 325 (HO); Mt. Brown, *L. Rodway*, Jan. 1910 (HO); Gilbert Leitch Huon Pine Reserve, *A. Moscal* 10916 (HO); Denison Range, *C. Elliott*, 2 Jan. 1947 (HO); Bonds Range, *A. Moscal* 1044 (HO); Jubilee Range, *A. Moscal* 9346 (HO); Swift Creek, Cape Sorell, *A.M. Buchanan* 2277 (HO); Mt La Perouse, *E.A. Rodway*, 29 Nov. 1898 (NSW).

**3. *Leptecophylla divaricata* (J.D.Hook.) C.M.Weiller, comb. nov.** *Lissanthe divaricata* J.D.Hook., Lond. J. Bot. 6: 269 (1847). *Type citation:* Hobart Town, Mt. Wellington, Swan Port; *Backhouse*, *Gunn*;— v.v.n. *Type:* 618/1842 *Lissanthe divaricata*, Mt. Wellington, 8/5/39, *Gunn* (lectotype, here designated, K). Six Gunn specimens and three labels with the locations Mt. Wellington, Swanport and Cornish Hill are present on a single sheet at K. The element selected as lectotype is on the right hand side of the sheet, in flower, from Mt. Wellington. Backhouse specimens, cited by Hooker, were not located at K or BM. *Cyathodes divaricata* (J.D.Hook.) J.D.Hook., Fl. Tasman. 1: 246, t. 74B (1857). *Styphelia renata* Sleum., Blumea 12: 156 (1963), *nom. superfl.*

*Cyathodes divaricata* *sensu* Benth., Fl. austral. 4: 170 (1868); Rodway, Tasman. fl. 114 (1903); W.M.Curtis, Stud. Fl. Tasman. 2: 428 (1963).

*Illustrations:* J.D.Hook., Fl. Tasman. 1: t. 74B (1857)

Dioecious, slender shrubs to 2 m high. *Stems* erect, grey-brown or grey; branchlets red-brown, rounded, scabrous. *Leaves* evenly spaced, absent on older stems, spreading or occasionally reflexed, narrowly ovate, 9.2–12.7 mm long, 1.2–1.5 mm wide, convex, apex acute, tip pungent, 0.6–1.4 mm long, margin recurved, glabrous, scaberulous or ciliolate, upper surface glabrous or occasionally puberulent near base; lower surface with intervenal papillae and 5 conspicuous parallel veins; *petiole* erect, 1–1.5 mm long, appressed to stem, puberulent. *Flowers* solitary, terminal and axillary, pendulous from bud, pedicel 3.1–5.8 mm long (male), 2–7.3 mm long (female); *bracts* ovate, 0.7 mm long, 0.4–0.6 mm wide, apices acute, glabrous or occasionally puberulent outside, ciliolate on the margins; *bracteoles* and *sepals* ovate with the midrib abaxially inconspicuous, glabrous; bracteoles 8–29 per flower, loosely imbricate below calyx, 1.1–1.8 mm long, 1.1–1.5 mm wide; sepals 1.6–2.9 mm long, 1.4–1.7 mm wide. *Corolla tube* exceeding calyx, thin, U-shaped, 5.5–6.7 mm long (male), 3.8–5 mm long (female), sparsely pubescent internally; *lobes* shorter than tube 1.7–2.2 mm long (male), 1.9–2.5 mm long (female), apices acute, externally glabrous, internally with long sparse hairs distributed overall inside. *Anthers* of male flowers 1.2–1.6 mm long, enclosed within corolla or half-exserted; *filaments* 0.2 mm long. *Ovary* spherical, 0.8–1.3 mm high, 0.9–1.5 mm wide, glabrous, 5(–6) celled; *style* usually bent, glabrous or pubescent near the middle, seated in an apical depression, 3.6–4.5 mm long (male), 3.7–5 mm long (female); *stigma* lobed, 0.1 mm high; *nectary* continuous, 0.4–0.6 mm high, with truncate or toothed shortly hairy margin. *Drupe* pale to dark pink, spherical, 6–10 mm high, 7–12 mm wide, apically depressed, glabrous, 1–5 locules with ovules developing into seeds, others aborting.  $n=12$  (Venkata-Rao 1961, as *Cyathodes*),  $2n=24$  (Smith-White 1955, as *Cyathodes*).

*Distribution and Habits:* Endemic to Tasmania, growing on dry rocky hillsides in open eucalypt forests of the eastern part of the state (Fig. 6).

*Flowering Period:* Mar.–Sept.

*Leaf Anatomy:* The leaf is 260–280  $\mu\text{m}$  thick with the adaxial cuticle 12.5  $\mu\text{m}$  and the abaxial cuticle 2.5–5  $\mu\text{m}$  thick. Papillae 20–22.5  $\mu\text{m}$  long with a rounded apex and slightly thickened walls occur in the stomatal regions. Adaxial epidermal cells are heavily lignified, 10–32.5  $\mu\text{m}$  long, 17.5  $\mu\text{m}$  wide; abaxial epidermal cells are narrowly lignified,



Fig. 6. Distribution of *Leptecophylla divaricata*.



Fig. 7. Distribution of *Leptecophylla pendulosa*.

7.5–10  $\mu\text{m}$  long, 10  $\mu\text{m}$  wide. Two rows of palisade mesophyll cells, 27.5–40  $\mu\text{m}$  long, 15–17.5  $\mu\text{m}$  wide, occur adaxially above open short-rectangular spongy mesophyll. Fibres occur only beneath the vascular bundles and the abaxial endodermal cells are unthickened.

**Chemical Data:** Ribbon wax covers the abaxial leaf surface. Wax composition is dominated by triterpenoids  $\alpha$ -amyrenone (21%),  $\beta$ -amyrenone (12%) and  $\alpha$ -amyrin (8%),  $C_{28}$  aldehyde (4%) and alcohol (9%). Triterpenes F and G are minor. Leaf flavonoid bisulphate A is present.

**Selected Specimens Examined:** AUSTRALIA. TASMANIA: Barbers Marsh, East Bagdad Rd 4 km due S of Quoin Mt, A.M. Gray 399 (HO); Organ Hill near Bicheno, A. Moscal 172 (HO); Black Charles Opening, A.M. Buchanan 3590 (HO); west ridge of Brown Mt, P. Collier, 15 June 1984 (HO); Sam Smiths Hill 2 km NE of Kaoota, A. Moscal 790 (HO); 'M' Rd T.P.F.H. private rd 5 km from Lake Leake Rd, A.M. Gray, 1 June 1978 (HO); Orford above Prosser River nr rubbish tip, M.G. Corrick 2104 (MEL); Cape Bernier, W.M. Curtis, 13 Jan. 1945 (HO); Lenah Valley Track, F.H. Long 366 (HO); Coles Bay, W.M. Curtis, Nov. 1948 (HO); South Island, Maria Is, M.J. Brown 219 (HO); Chimney Pot Hill, R.K. Crowden 8307-01; Hospital Creek, C.M. Mihaich 1; Grasstree Hill, D.A. & A.V. Ratkowsky 417 (NSW); Spring River, W.M. Curtis, 9 Sept. 1951 (HO); Piermont, mouth of Stony River, S of Swansea, S. Harris, 25 Jan. 1979 (HO); Mt Nelson, Rodway 153 (HO); Mt Direction, F.A. Rodway, June 1922 (NSW).

**4. *Leptecophylla pendulosa* (S.J. Jarman) C.M. Weiller, comb. nov.** *Cyathodes pendulosa* S.J. Jarman, Pap. Proc. Roy. Soc. Tas. 112: 2 (1978). **Type citation:** Foothills of Ben Lomond, Tasmania, 16 June 1976, R.K. Crowden & S.J. Jarman (holotype HO).

Dioecious, diffuse or compact shrubs to 1.5 m high. Stems erect, brown or grey-brown; branchlets brown, rounded, pubescent. Leaves evenly spaced, spreading, narrow ovate, 3.8–7.9 mm long, 0.9–1.8 mm wide, flat, apex acute, tip pungent 0.6–0.9 mm long, margin flat or slightly recurved, ciliate, upper surface glabrous, lower surface with intervenal papillae and 3–5 conspicuous veins; petiole erect, 0.4–1 mm long, appressed to stem, glabrous or occasionally puberulent on the upper surface. Flowers solitary, usually terminal only but also axillary, erect or pendulous from bud, pedicel 2.3–4 mm long; bracts weakly keeled, ovate, 0.4–0.7 mm long, 0.3–0.6 mm wide, apices obtuse, puberulent outside, ciliolate on the margins; bracteoles and sepals ovate with the midrib abaxially inconspicuous, glabrous or sparsely pubescent inside; bracteoles 13–37 per flower, imbricate, 1.7–2.9 mm long, 1.3–2 mm wide; sepals ovate to elliptic, 2.6–3.6 mm long, 1.2–2.2 mm wide. Corolla tube exceeding calyx, thin, U-shaped, or campanulate, 3.2–4.3 mm long (male), 2.8–3.5 mm long (female), glabrous; lobes shorter than tube 1.7–2.3 mm long, apices acute, externally glabrous or rarely with a few hairs at the base of the lobes, internally glabrous. Anthers of male flowers 1–1.4 mm long, enclosed within corolla; filaments 0.1–0.2 mm long. Ovary spherical, 0.5–1 mm high, 0.6–1 mm wide (male), 1–1.4 mm high, 1–1.4 mm wide (female), glabrous, (4–)5(–6) celled; style bent, glabrous, seated in an apical depression, 3.1–4.4 mm long (male), 2.1–2.9 mm long (female); stigma lobed, 0.1 mm high; nectary continuous, 0.4–0.7 mm high, glabrous, with toothed upper margin. Drupe pink, spherical, 6.3–9 mm high, 6–10 mm wide, apically depressed, glabrous, 0–5 locules with ovules developing into seeds.

**Distribution and Habitat:** Endemic to Tasmania, occurring in rocky, open eucalypt woodland in the north-east (Fig. 7).

**Flowering Period:** May–July.

**Leaf Anatomy:** Leaf 230–240  $\mu\text{m}$  thick with adaxial and abaxial cuticles 5  $\mu\text{m}$ . Papillae with a rounded apex, 17.5  $\mu\text{m}$  long cover the stomatal regions. Adaxial epidermal cells are heavily lignified, 25–32.5  $\mu\text{m}$  long, 16.3–18.8  $\mu\text{m}$  wide; abaxial epidermal cells are narrowly lignified, 7.5–12.5  $\mu\text{m}$  long, 11.3–15  $\mu\text{m}$  wide, smaller beneath the veins than in the stomatal areas. A single row of palisade cells 45–62.5  $\mu\text{m}$  long, 15  $\mu\text{m}$  wide

are associated with an open spongy mesophyll consisting of short-rectangular cells. Fibres are abaxial to the vascular bundles and the endodermal cells unthickened.

*Chemical Data:* Ribbon wax covers the abaxial leaf surface. Wax composition is dominated by triterpenoids (69%)  $\alpha$ -amyrin,  $\beta$ -amyrin and  $\beta$ -amyrenone with F and G minor components. Leaf flavonoid bisulphate A is present.

*Specimens Examined:* AUSTRALIA. TASMANIA: Nicholls Cap, *P. Collier*, 5 May 1984 (HO); Nicholls Cap summit, *A. Moscal* 181 (HO); Nicholls Cap W of Seymour Beach, *S. Harris*, 25 Jan. 1979 (HO); Mt Nicholas, *R.K. Crowden* 78-16; Mt Allen, *A. Moscal* 174 (HO); Bedgood Hill, near Bicheno, *A. Moscal* 240 (HO); top of St Patricks Head, St Marys, ex Herbarium Miss F. Brumby, July 1876 (MEL); St Patricks Head, *A.M. Buchanan* 918 (HO); St Patricks Head State Reserve, *A. Moscal* 2442 (HO); NE slope of Mt Saddleback, *P. Collier*, 1 July 1984 (HO); Scamander, *L. Rodway*, May 1892 (HO); Big Peppermint Hill, *A. Moscal* 375 (HO); Tower Hill, *A.M. Gray*, 31 May 1978 (HO); 8 km along Valley Rd, Fingal Tier, *P. Collier* 504 (HO); St Pauls River E of Cutoff Hill, *P. Collier* 521 (HO); Northsister, *A. Moscal* 770 (HO); Lake Leake, *R.K. Crowden* 8307-02; 'M' Road, *C.M. Mihaich* 31; Meetus Falls, *C.M. Mihaich* 32.

**5. *Leptecophylla robusta* (J.D. Hook.) C.M. Weiller, comb. nov.** *Cyathodes acerosa* (Gacrt.) R. Br. ex Roem. & Schult. var. *latifolia* J.D. Hook., Fl. nov.-zel. I: 163 (1853). *Type citation:* Chatham Is., Dieffenbach (holotype K). *Cyathodes robusta* J.D. Hook., Handb. N. Zeal. II. 177 (1864). *Styphelia robusta* (J.D. Hook.) Sleum., Blumea 12: 159 (1963).

*Cyathodes acerosa* var. *latifolia* *sensu* Mueller, Veg. Chath.-Isl. 43 (1864). *Cyathodes robusta* *sensu* Cheeseman, Man. New Zealand fl. 411 (1906); Cheeseman, Man. New Zealand fl. 695 (1925); Allan, Fl. New Zealand I: 516-517 (1961).

Dioecious, shrubs or trees to 5 m high. Stems grey-brown or grey. Branchlets yellow-brown or brown, rounded, puberulent. Leaves erect or spreading, ovate or oblong, 9.9-16.2 mm long 2.2-3.4 mm wide, flat, apex obtuse, with a callus tip; margin recurved slightly, glabrous or ciliolate only at the apex, upper surface glabrous, lower surface with interventional papillae and 6-8 conspicuous veins; petiole 1.3-2 mm long, puberulent on the upper surface. Flowers solitary, terminal and axillary, erect, pedicel 3.1-4.1 mm long (male), 2.4-3.2 mm long (female); bracts triangular, 0.7-9 mm long, 0.9-1.4 mm wide, apices obtuse, glabrous outside, ciliolate on the margins toward the apex; bracteoles and sepals glabrous, conspicuously striate when dry; bracteoles 9-21 per flower, imbricate, 1.7-2.2 mm long, 1.5-2.1 mm wide; sepals ovate, 2.1-2.6 mm long, 1.6-2.1 mm wide. Corolla tube usually equal to calyx, thin, U-shaped, 1.7-2 mm long; lobes more or less equal to tube 1.7-2.1 mm long, apices broadly acute, glabrous or internally occasionally sparsely hairy. Anthers of male flowers 1.1-1.4 mm long, usually enclosed within corolla; filaments 0.4-0.7 mm long. Ovary spherical, 0.7-1.1 mm high, 0.9-1.1 mm wide, glabrous, 4 or 5 celled; style straight, glabrous, tapering to the ovary, 1.1-1.4 mm long (male), 0.9-1.2 mm long (female); stigmas 0.1 mm high; nectary continuous, 0.4-0.7 mm high, usually with a toothed upper margin. Drupe red, spherical, 5-6 mm high, 6-9 mm wide, 2-5 locules with ovules developing into seeds.

*Distribution and Habitat:* Endemic to the Chatham Islands, New Zealand, in rocky areas.

*Flowering Period:* Oct.-Nov.

*Leaf Anatomy:* The leaf is 370-390  $\mu\text{m}$  thick with the adaxial cuticle c. 12.5  $\mu\text{m}$  and the abaxial cuticle 5  $\mu\text{m}$ . Thick walled papillae with a rounded apex 20  $\mu\text{m}$  long cover the stomatal regions. Adaxial epidermal cells are lignified, 25-27.5  $\mu\text{m}$  long, 15-27.5  $\mu\text{m}$  wide; abaxial epidermal cells are narrowly lignified, 5-10  $\mu\text{m}$  long, 10  $\mu\text{m}$  wide, smaller beneath the veins. Two rows of palisade cells 62.5-92.5  $\mu\text{m}$  long, 16.3-20  $\mu\text{m}$  wide, are associated with a compact spongy mesophyll composed of small rounded cells. Several fibre cells are occasionally present above the vascular bundles in addition to the abaxial arc. Endodermal cells are unthickened.

**Chemical Data:** Ribbon wax covers the abaxial leaf surface. Wax composition is dominated by triterpenoids  $\alpha$ -amyrenone (31%),  $\beta$ -amyrenone (15%),  $\alpha$ -amyrin (5%). F and F1 with the  $C_{28}$  homologue of the aldehyde (8%) and alcohol (11%) constituting most of the remainder of the wax.

**Specimens Examined:** NEW ZEALAND. CHATHAM ISLANDS: *E.A.D. Cox*, Oct. 1900 (AK, CHR); near Waikato Point, *M.A. & I.M. Ritchie*, 17 Sept. 1968 (CHR); Tuku Creek area, SW Chathams, *K. Olsen*, 7 Jan. 1978 (AK); Taiko Hill, *K.P. Olsen*, 12 Jan. 1978 (AK); Waitangi, West Moorland, 7 Feb. 1985, *B. Molloy*; Chudleigh Reserve at Waimahana Creek, *D.R. Given* 12773 & *P.A. Williams* (CHR); Te Awatea, *E. Madden* 108 (CHR); Nairn River, *G. Hamel*, 27 Jan. 1976 (CHR); pen ground 1 km SE of Lake Rotokawau near pond, *D.R. Given* 12759 & *P.A. Williams* (CHR); Tobacco County S of Chatham Is, *Cox & Cockayne*, Feb. 1901 (AK); Kahiti Stream near Owenga, *B.G. Hamilton*, 1948 (WELT); Southern Table-land above Te Awainanga River, *A.T. Moar* 568, 1569, 1570 (CHR); *A. Sinclair*, 1850-1860 (NSW).

**6. *Leptecophylla abietina* (Labill.) C.M. Weiller, comb. nov.** *Styphelia abietina* Labill., Nov. Holl. pl. 1: 48, t. 68 (1805). **Type citation:** Capite van Diemen, *Labill.* (lectotype here designated, FI-WEBB sheet number 118262, seen in photo). There are three sheets at FI-WEBB. The sheet selected as lectotype comprises a single fruiting specimen and carries extensive descriptive notes in Labillardière's hand. *Cyathodes abietina* (Labill.) R. Br., Prodr. 540 (1810).

*Styphelia abietina* sensu Poir., Encycl. 7: 486 (1806); Spreng., Syst. veg. 1: 659 (1824); F. Muell., Fragm. 6: 43 (1867); Sleum., Blumea 12: 155 (1963) in key.

**Illustrations:** Labill., Nov. Holl. pl. 1: t. 68 (1805). *Cyathodes abietina* sensu Roem. & Schult., Syst. veg. 4: 472 (1819); G. Don, Gen. hist. 3: 776 (1834); DC., Prodr. 7: 741 (1839); J.D. Hook. Fl. Tasman. 247 (1857); Rodway, Tasman. fl. 114 (1903); W.M. Curtis, Stud. fl. Tasman. 2: 427 (1963).

Dioecious, compact, erect shrubs 1–2 m high. *Stems* grey or grey-brown; *branchlets* brown or rarely yellow-brown, densely puberulent. *Leaves* evenly spaced, usually absent on main stems, sub-erect, narrowly ovate, flat, 12.3–18 mm long, 1.9–2.7 mm wide, tip short and hard, the mucro 0.3–1.2 mm long; margin flat, glabrous or ciliolate toward the apex, upper surface green, glabrous or with sparse hairs toward the base, lower surface with short trichomes fringing shallow grooves and up to 7 veins; *petiole* erect, 1.8–3.1 mm long, appressed to stem, sparsely puberulent. First leaves of new season's growth obovate, 11–19 mm long, 3.1–5.2 mm wide, margin hyaline to scarious. *Flowers* solitary, terminal and axillary on erect pedicels 3.5–4.2 mm long (male), 2.4–3 mm long (female); *bracts* broadly ovate, 0.8–1 mm long, 0.8–1.1 mm wide, obtuse, margin usually glabrous; *bracteoles* and *sepals* broadly ovate, obtuse, glabrous, conspicuously striate when dry; bracteoles 6–26 per flower, imbricate, 2.1–2.6 mm long, 1.9–2.4 mm wide; sepals 2.8–3.8 mm long 2–2.6 mm wide. *Corolla* tube thick, fleshy, exceeding calyx, campanulate, 4–4.5 mm long (male), 3–3.2 mm long (female), upper half sparsely pubescent internally; *lobes* 2–3.1 mm long, externally glabrous or with a few short hairs at the base of the lobes, internally densely bearded, short at the apex, long below, apex broadly acute to obtuse, thickened. *Anthers* of male flowers 1.8–2.6 mm long, half exserted; *filaments* 0.4–0.6 mm long. *Ovary* spherical 1.1–1.2 mm high, 1.1–1.5 mm wide, glabrous, 4–7 celled; *style* glabrous, attenuate from the ovary, 1.4–1.8 mm long (female), 1.8–2.3 mm long (male); *stigma* lobed; *nectary* 0.5–0.8 mm high, separating into scales with pressure, margin toothed. *Drupe* pale to dark pink, 5–9 mm high, 7–12 mm wide, slightly flattened sphere, surface dull, mesocarp dry.

**Distribution and Habitat:** Endemic to Tasmania, restricted to the exposed rocky coasts of the SE, S and W and neighbouring islands between Southport Bluff in the SE to Trial Harbour on the W coast. Also recorded from Walker Is. off the NW coast and South Arm in the SE (Fig. 8).

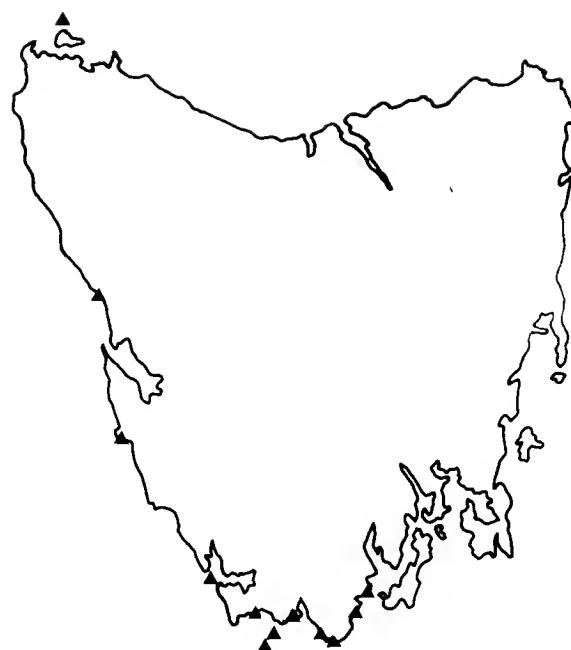


Fig. 8. Distribution of *Leptecophylla abietina*.

*Flowering Period:* Oct.–Nov. (–Apr.)

*Leaf Anatomy:* The average leaf thickness is 500–550  $\mu\text{m}$  with the adaxial cuticle 17.5–22.5  $\mu\text{m}$  thick and the abaxial cuticle 12.5–17.5  $\mu\text{m}$ . Intervenal grooves 120–150  $\mu\text{m}$  deep are lined with heavily cutinised trichomes 60  $\mu\text{m}$  long. Stomata occur at the base and sides of the grooves level with surrounding epidermal cells. Adaxial epidermal cells are large, c. 37.5  $\mu\text{m}$  long, 25  $\mu\text{m}$  wide and heavily lignified; abaxial epidermal cells are much smaller, 15–20  $\mu\text{m}$  long, 10–12.5  $\mu\text{m}$  wide, with less thickening. Two to three rows of elongate palisade mesophyll cells, c. 60  $\mu\text{m}$  long, 20  $\mu\text{m}$  wide, and short rectangular spongy mesophyll cells are present. Fibres form an arc beneath the vascular bundles, and 'endodermal' cells between the fibres and abaxial epidermis are lignified.

*Chemical Data:* Ribbon wax is confined to the intervenal grooves and the short trichomes lining them. Wax composition is dominated by triterpenoids  $\beta$ -amyrinone,  $\alpha$ -amyrinone, F and F1 (total 68 %) with hydrocarbons  $C_{29}$  (1 %),  $C_{11}$  (2 %) and the aldehyde homologue  $C_{28}$  (1 %) of minor significance. Leaf flavonoid bisulphates are absent.

*Selected Specimens Examined:* AUSTRALIA, TASMANIA: Southport Bluff, P. Collier 742 (HO); Southport Island, C. Stuart 1677, Sept. 1855 (MEL); South Cape Bay, H.F. Comber (HO), A.M. Buchanan 3165 (HO); Shoemaker Bay, A.M. Buchanan 3520 (HO); Cox Bight, south end of Black Cliff Hills, A.M. Buchanan 3385 (HO); W end of Turua Beach, A.M. Buchanan 3441 (HO); W end of Prior Beach, A.M. Buchanan 3462 (HO); end of Little Lagoon Beach, P. Collier 739 (HO); De Witt Islands, L. Rodway (HO); Maatsuyker Is. A. Moscal, Aug. 1976 (HO), A. Moscal, Nov. 1976 (HO); Trumpeter Is., entrance to Port Davey, G. White, 28 Dec. 1980 (HO); Hobbs Is., entrance to Port Davey, G. White, 28 Dec. 1980 (HO); Flat Witch Is., G. White, 23 Dec. 1978–8 Jan. 1979 (HO); Niblin Point, A.M. Buchanan 2497 (HO); rocky coast between Meerin Beach and Evans Creek, A.M. Buchanan 2874 (HO); Rupert Point, W.D. Jackson, Jan. 1954 (HO); South Arm, River Derwent, S. Paswania, (?)Sept. 1938 (NSW).

### New Guinean and Pacific island species of *Leptecophylla*

*Leptecophylla* also includes seven species distributed in New Guinea and through the Pacific. Detailed examination of these species was beyond the scope of this study and consequently descriptive treatments and full synonymy for these species is omitted. A limited number of specimens of the first three species were examined as well as type material of all species. New combinations are given for these species, accompanied by type and distribution information, some taken from Sleumer (1963):

***Leptecophylla brassii*** (Sleum.) C.M.Weiller, *comb. nov.* *Styphelia brassii* Sleum., *Blumea* 12: 160 (1963). *Type citation:* Mt Maneao, 2750-2855 m, Brass 22274 (holotype L n.v.; isotypes A n.v., CANB, LAE n.v.). Restricted to New Guinea.

***Leptecophylla imbricata*** (Stschegl.) C.M.Weiller, *comb. nov.* *Cyathodes imbricata* Stschegl., *Bull. Soc. Nat. Moscou* 32: i 10 (1859). *Type citation:* Insulae Sandvicenses [Mauna Kea], *D.Douglas* 19 (holotype LE n.v.; isotypes G n.v., K).

*Cyathodes douglasii* A.Gray, *Proc. Am. Acad.* 5: 325 (1861). *Type citation:* Mauna Kea, *Douglas* s.n. (lectotype GH, *fide* H. Sleumer (1963), *Blumea* 12: 157). *Styphelia douglasii* (A.Gray) F.Muell. ex Skottsberg, *Act. Hort. Gothob.* 2: 255 (1925). Hawaii, Molokai, Maui, and Kauai.

***Leptecophylla tameiameiae*** (Cham. & Schltdl.) C.M.Weiller, *comb. nov.* *Cyathodes tameiameiae* Cham. & Schltdl., *Linnaea* 1: 539 (1826). *Type citation:* in clivis aridioribus ad radices montium circa Hana-ruru [Honolulu] insulae O-Wahu [Oahu], *Eschscholtz* (holotype LE n.v.; isotypes B n.v., G n.v., K, L n.v., P n.v.). *Styphelia tameiameiae* (Cham. & Schltdl.) F.Muell., *Fragm.* 6: 55 (1867). Hawaiian and Marquesas Islands.

***Leptecophylla pomarae*** (A.Gray) C.M.Weiller, *comb. nov.* *Cyathodes pomarae* A.Gray, *Proc. Am. Acad.* 5: 324 (1862). *Type citation:* Society Islands, on the mountains of Tahiti, U.S. Expl. Exp., *Pickering* s.n. (holotype GH n.v.; isotypes K, NY n.v.). *Styphelia pomarae* (A.Gray) Moore, *Bern. P. Bish. Mus. Bull.* 102: 36 (1933). Tahiti, Society Islands.

***Leptecophylla rapae*** (Sleum.) C.M.Weiller, *comb. nov.* *Styphelia rapae* Sleum. *Blumea* 12: 159 (1963). *Type citation:* Tubai Is. Rapa I.: Kaimura mountain ridge, .... hillside near sea, 7-30 m, fl. fr. 6-11-1921, *Stokes* 421 (holotype BISH). Rapa Island, Tubai Islands.

***Leptecophylla brevistyla*** (J.W.Moore) C.M.Weiller, *comb. nov.* *Styphelia brevistyla* J.W.Moore, *Bull. Bern. P. Bish. Mus.* 102: 36 (1933). *Type citation:* Temehani plain, [Raiatea], 470 m, 21 Sept. 1926, *J.W. Moore* 106 (holotype BISH, isotypes BISH). Society Islands.

***Leptecophylla mariannensis*** (Kaneh.) C.M.Weiller, *comb. nov.* *Cyathodes mariannensis* Kaneh., *Bot. Mag. Tokyo* 48: 734, f. 5 (1934). *Type citation:* Aramagan I., Marianne Islands, July 6 1933, *Kanehira* 2182 (holotype FU n.v.; isotypes K, P n.v.). *Styphelia mariannensis* (Kaneh.) Kaneh. & Hatus., *Bot. Mag. Tokyo* 56: 484, in text (1942). Marianas.

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## *Triglochin protuberans* (Juncaginaceae): a New Species from Western Australia

Helen I. Aston

c/o National Herbarium of Victoria, Birdwood Avenue, South Yarra, Victoria 3141, Australia.

### Abstract

*Triglochin protuberans* Aston sp. nov., an annual species from south-western Western Australia, is described and its diagnostic features illustrated.

### Introduction

Collections of Juncaginaceae from all major herbaria in Australia were obtained on loan for preparation of the family account for the *Flora of Australia*. Amongst specimens of the annual species of *Triglochin*, several consistently similar collections differing from already described taxa were located. D.C. Edinger later forwarded two further collections of the new entity. This is now described here as a new species, *T. protuberans*.

### Taxonomy

#### *Triglochin protuberans* Aston, sp. nov.

Herba annua, 3-13 cm alta. Folia gracilia, c. teretia, 1-7 cm longa, breviora scapo fructifero; vaginae auriculis latis obtusis terminatis. Infructescencia racemus laxus est, 1-6 cm longa, fructibus 2-8 in pedicellis 1.5-5(-9) mm longis. Fructus c. anguste angulo-ovati (anguste trullati) in circumscriptione, (4-)4.7-6.1 mm longi, loco latissimo 1.1-1.6 mm diametris. Carpella fertilia matura 3, connata ventraliter; pagina dorsalis marginem rotundatam et sulco longitudinali ad costam porca demissa angusta inclusa, margines quoque prope basin protuberatio facti; carpellum infra portuberationes duos contractum deorsum.

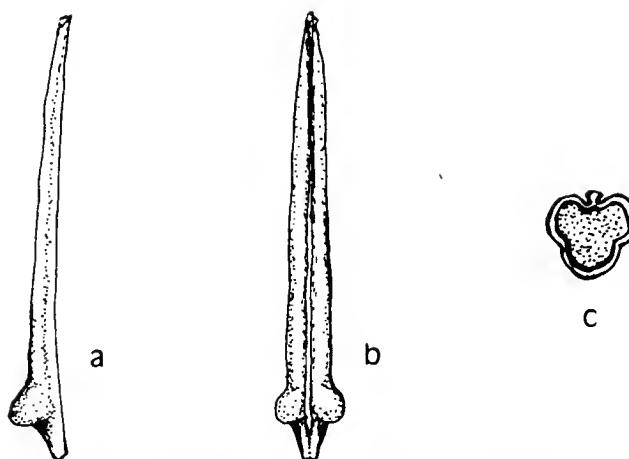
*Type:* Western Australia, 8 miles [12.9 km] E of Malcolm, A.S. George 2764, 22.viii.1961 (holotype PERTH).

Annual herb, 3-13 cm high. *Leaves* ± terete, often thread-like, 1-7 cm long, 0.2-0.5 mm diam., always much shorter than the infructescence and usually less than half as long; basal sheath with broad obtuse, rarely shortly pointed, auricles to 0.25 mm long. Scape at fruiting erect to spreading, 2-13 cm long, 0.25-0.4 mm diam. *Inflorescence* insufficiently known. *Infructescence* a lax open raceme 1-6 cm long, 5-12 mm diam.; pedicels c. 1.5-5(-9) mm long, 0.1-0.2 mm diam. Fruits c. 2-8 per infructescence, ± narrowly angular-ovoid (narrowly trullate) in outline, (4-)4.7-6.1 mm long, 1.1-1.6 mm diam. across the near-basal bulges. Carpels 6, 3 fertile alternating with 3 sterile, ventrally united; dorsal surface of each mature fertile carpel with rounded edges and with a longitudinal groove containing a low narrow ridge down its midline, each edge developing into a rounded bulge near the carpel base or rarely the bulges lacking; carpel tapered downwards below the two bulges; mature carpels readily separating; sterile carpels forming a persistent, 3-winged carpophore. (Fig. 1)

*Phenology:* Flowers and fruits Aug. - Oct.

*Etymology:* The epithet *protuberans* refers to the typically prominent bulges which occur near the base of mature fertile carpels. A suggested English name for the species is *Bulged Arrowgrass*.

*Distribution and Conservation Status:* Known only from six collections from south-



**Fig. 1.** *Triglochin protuberans*, mature fertile carpels (George 2764): a lateral view, x 12; b dorsal view, x 12; c transverse section from above the bulges, dorsal surface at top, x 10.

western Western Australia, with three from the Yalgoo to Paynes Find area, one from Malelom, one from the Stirling Range, and one from an indefinite locality. The species is likely to occur at other sites but to have been insufficiently collected. The only measure of abundance given on herbarium labels is "common" for Keighery 8786. It is poorly known and rates a conservation code of 3K (Briggs and Leigh 1995).

**Habitat:** Apparently from ephemeral freshwater sites although one collection (Keighery 8786) is from the vicinity of a salt lake. Specimen labels indicate that collections were from red loam along a creek (type collection), from grey mud over clay in winter-wet flats, around claypans in open Mulga scrub, and at the margin of a pool in low *Acacia* woodland over sparse scrub and ground vegetation.

**Notes:** *Triglochin protuberans* has distinctive fruits and obtuse, not long-tapered and acute, sheath auricles. Although not confined to this species, the open, few-fruited infructescence is an additional aid to identification. The collection from the Stirling Range (Keighery 8786) is unusual in lacking the carpel bulges but agrees in all other aspects of habit and fruit.

Until now, the few collections of *T. protuberans* have been placed under *T. centrocarpum* (*sens. Aust. anct. var. non* Hook. *sensu stricto*.)

**Specimens examined:** WESTERN AUSTRALIA: W.A. [no precise locality], J. Drummond s.n., date unknown (MEL 2056601; MEL 2056602); Yalgoo, C.A. Gardner 7754, 10.x.1945 (PERTH); Unnamed salt lake SE of Ellens Peak, Stirling Range, G.J. Keighery 8786, 28.x.1983 (PERTH); SW corner of Marda Marda Paddock, Burnerbinmah Station, NW of Paynes Find, S. Toole et al. 51, 11.ix.1996 (PERTH); Near Marda Marda Bore, Marda Marda Paddock, Burnerbinmah Station, coll. ?, 20.viii.1997 (PERTH).

### Acknowledgements

I thank the heads and staff of PERTH, DNA, AD, BRI, NSW, CANB, MEL, and HO for providing collections on loan or allowing on-site access to them. I particularly thank Daphne Edinger (PERTH) for forwarding the two most recent collections and Neville Walsh (MEL) for preparing the Latin description.

## A New Species of *Pseudocyphellaria* (Lichenised Fungi), With a Key to the Tasmanian Species

G. Kantvilas<sup>1</sup> and J.A. Elix<sup>2</sup>

<sup>1</sup>Tasmanian Herbarium, GPO Box 252-04, Hobart, Tasmania 7001, Australia.

<sup>2</sup>Chemistry Department, The Faculties, Australian National University, Canberra, A.C.T. 0200, Australia.

### Abstract

*Pseudocyphellaria soredioglabra* Kantvilas and Elix is described. The new species is endemic to Tasmania and differs from its nearest relative, *P. glabra* (Hook.f. & Taylor) Dodge, its marginally granular-sorediate lobes. A key to all 18 species of *Pseudocyphellaria* in Tasmania is provided.

### Introduction

In preparation for a review of the composition, distribution and conservation status of the Tasmanian lichen flora (Kantvilas in prep.), we are describing a new species of *Pseudocyphellaria*.

*Pseudocyphellaria* is a very prominent and diverse genus of conspicuous, large, foliose lichens, especially in the Southern Hemisphere. Considerable information on the morphology, anatomy, biogeography and ecology of the genus has been published, especially in the major regional revisions for New Zealand (Galloway 1988), South America (Galloway 1992) and the palaeotropics (Galloway 1994).

Eighteen species are known from Tasmania, a relatively low level of diversity in comparison to New Zealand where 50 species are known (Malcolm & Galloway 1997). Most Tasmanian species (15) occur in high rainfall areas, especially in cool temperate rainforest and associated vegetation types such as wet scrub, alpine heathland and some wet sclerophyll forests (Kantvilas 1995). However, one species, *P. neglecta*, is confined to eucalypt forest, especially in low rainfall areas, whereas another, *P. aurata*, is confined to coastal swamps. The new species is also a non-rainforest lichen.

The closest relationships of the Tasmanian species of *Pseudocyphellaria* are with New Zealand and mainland Australia, with 15 of the 18 Tasmanian species being shared with these regions. In contrast, only ten of the taxa occur in South America. Two species are endemic to Tasmania: *P. brattii* and the new species, an unusually low level of endemism in comparison to, for example, southern South America, where 72% of the species are endemic (Galloway 1992) and New Zealand, where approximately half are endemic (Galloway 1988).

### Materials and Methods

The study is based on collections in the Tasmanian Herbarium (HO) and the authors' field observations in Tasmania. Chemical analyses follow standard methods (Culberson 1972; Elix & Ernst-Russel 1993; Feige *et al.* 1993).

#### *Pseudocyphellaria soredioglabra* Kantvilas & Elix, sp. nov.

Species habitu et compositione chemicali *Pseudocyphellariae glabrae* proxissima, marginibus loborum dense sorediatis granularibus manifeste differt.

*Type*: Australia, Tasmania, ridge east of Ouse River, 4.5 km west of Liawenee, 41°54'S, 146°37'E, on dolerite rocks in alpine heathland, 1140 m altitude, 7 December 1993, J.A. Elix 40061 & G. Kantvilas 184/93. (holotype HO; isotypes CANB, BM).

*Thallus* irregularly spreading or rosette-forming, to c. 20 cm wide when well developed, loosely attached and easily separable from the substratum. *Lobes* very variable, imbricate throughout or  $\pm$  discrete, strap-like and contiguous, and radiating towards the thallus margins, 35–120 mm long, (3–)7–13 mm wide, rather leathery and robust, 200–400  $\mu\text{m}$  thick; apices  $\pm$  irregularly rounded, crenulate,  $\pm$  adnate to the substratum or slightly ascending; margins ascending, crenate, irregularly incised, or at times, sinuate, densely and  $\pm$  continuously sorediate except near the lobe apices; soredia whitish or pale yellowish-white, coarsely granular to granular-glomerulate, sometimes  $\pm$  pseudoisidiate. *Upper surface* pale yellow to yellowish-green, sometimes discoloured brownish in the thallus centre, undulate, smooth to weakly scrobiculate in older lobes, glossy, glabrous, emaculate. *Lower surface* black centrally, becoming dark brown or pale brown towards the lobe apices, smooth to weakly wrinkled, occasionally bullate in older parts, with dense, dark brown to brown tomentum c. 0.3–0.6 mm long, composed of tangled hyphae, 6–14(–20)  $\mu\text{m}$  thick, typically continuous and extending almost to the lobe apices, but sometimes rather patchy in the centre of the thallus. *Pseudocyphellae* confined to the lower surface, white, scattered, few to numerous, especially in younger lobes, roundish, to 0.25–0.7 mm wide, plane, not excavate, sometimes slightly elevated in conical verrucae, or nestling amongst tomental hyphae. *Medulla* white. *Photobiont* a unicellular green alga with globose cells, 10–14  $\mu\text{m}$  diam. *Apothecia* unknown (Fig. 1).

*Chemistry*: hopane-15 $\alpha$ , 22-diol (major), 7 $\beta$ -acetoxyhopane-22-ol (major), stictic acid (major), constictic acid (minor), cryptostictic acid (minor), norstictic acid (trace), usnic acid (minor); medulla Pd+ orange, K+ yellow, C-, KC-, UV-.

*Remarks*: *Pseudocyphellaria soredioglabra* is most closely related to the widespread austral species, *P. glabra*, both lichens having a yellowish thallus with broadly rounded, spreading, adnate lobes and a dark brown tomentum on the lower surface, a white medulla, white pseudocyphellae, a green photobiont and identical chemical composition. The new species differs in having copiously sorediate margins, whereas *P. glabra* is isidiate. In general, soredia are uncommon amongst *Pseudocyphellaria* species with a

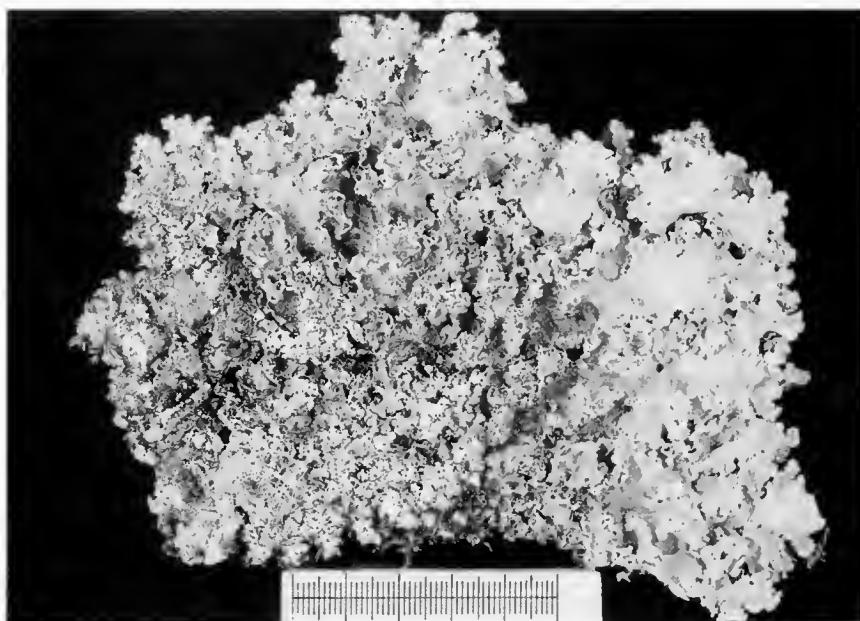
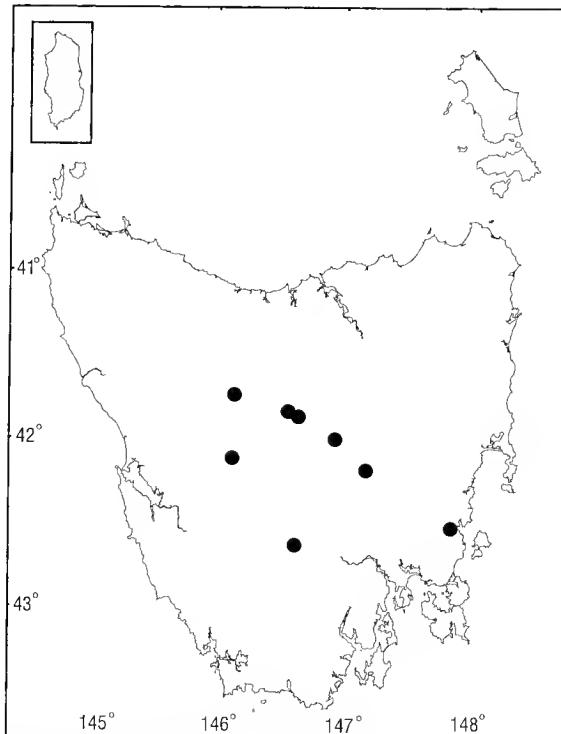


Fig. 1. *Pseudocyphellaria soredioglabra* holotype (Scale in mm)



**Fig. 2.** Distribution of *Pseudocyphellaria soredioglabra*.

green photobiont and white medulla. In the austral and Australasian regions, there is only one additional sorediate taxon, *P. granulata*, which differs in having a grey-green upper surface, rather elongate, faveolate lobes and a completely different chemical composition. The soredia of both this lichen and the new species may be particularly coarse and at times become virtually pseudoisidiate (see also Galloway 1992: 35).

*Pseudocyphellaria soredioglabra* is known only from Tasmania where it occurs in open eucalypt woodland and heathland, especially at subalpine to alpine altitudes (see Fig. 2). It occurs mostly on dolerite rocks, and more rarely on wood or bark, associated with *Cladia aggregata*, *Parmelia labrosa*, *Usnea torulosa*, *Pseudocyphellaria crocata*, *P. glabra* and *Parmelia signifera*.

*Specimens examined:* AUSTRALIA, TASMANIA: Table Mountain, 42°14'S, 147°08'E, 1095 m altitude, G.C. Bratt & J.A. Cashin 72/435, 18.vi.1972 (AD, HO); Prosser River, 42°34'S, 147°52'E, G. Kantvilas 312/80, 23.viii.1980 (BM, HO); Mt Rufus, 42°07'S, 146°07'E, 1120 m altitude, G.C. Bratt & J.A. Cashin 72/1002, 8.x.1972 (HO); Lake Dobson, 42°42'S, 146°36'E, 1030 m altitude, G.C. Bratt & D. Norris 73/1160, 17.xi.1973 (HO); Mt Penny West, 42°02'S, 146°56'E, 1130 m altitude G.C. Bratt & K.M. Mackay 69/166, 4.iv.1969 (HO); Arm River Track, 41°48'S, 146°08'E, 800 m altitude, D. & M. Cook 75/252, ii.1975 (HO); Little Split Rock, 41°49'S, 146°31'E, 1240 m altitude, A. Moscal 6691, 6692, 1.iii.1984 (HO).

#### Key to Tasmanian species of *Pseudocyphellaria*

1. Medulla yellow ..... 2
1. Medulla white (pseudocyphellae and soralia may be yellow or white) ..... 6
2. Thallus sorediate; soralia yellow ..... 3
2. Thallus not sorediate ..... 5

3. Upper surface thickly tomentose; photobiont green; soralia marginal and laminal.....  
.....*P. rubella*

3. Upper surfacee not tomentose; photobiont green or blue-green; soralia marginal only.  
.....4

4. Photobiont blue-green; upper surface grey when dry, bright slatey blue-grey when wet; found in rainforest and wet serub.....*P. ardesiaca*

4. Photobiont green; upper surfacee grey when dry, becoming pale reddish brown in storage, bright green when wet; found in coastal swamps.....*P. aurata*

5. Lobes  $\pm$  elongate, with incised-serrate margins; isidia present, mainly marginal but sometimes also laminal; apothecia to 3–4 mm diam., with serrate,  $\pm$  isidiate margin and reddish brown disc; medulla acetone+ orange-yellow or yellow.....*P. coleusoi*

5. Lobes  $\pm$  rounded, with entire margins; isidia absent; apothecia 1–1.5 mm diam., with  $\pm$  crenulate margin and  $\pm$  blaek disc; medulla acetone+ magenta .....*P. coronata*

6. Thallus dark blue-green when wet, blue-grey, brown-grey or dark red-brown when dry; photobiont blue-green.....7

6. Thallus green, green-grey or pale yellow-green when wet or dry; photobiont green...  
.....13

7. Thallus sorediate .....8

7. Thallus not sorediate .....9

8. Pseudocyphellae yellow; soralia yellow; thallus usually brown when dry...*P. crocata*

8. Pseudocyphellae white; soralia white, pale violet or bluish grey; thallus usually blue-grey when dry .....*P. intricata*

9. Pseudocyphellae yellow; thallus usually brown when dry .....10

9. Pseudocyphellae white; thallus brown or blue-grey when dry .....11

10. Thallus with marginal and laminal phyllidia; common on rocks or soil, especially in dry selerophyll forest .....*P. ueglecta*

10. Thallus lacking phyllidia; rather rare on rocks or tree buttresses, mainly in wetter habitats .....*P. gilva*

11. Thallus with coraloid, marginal and laminal isidia, and with minute, punetiform pseudocyphellae on the upper surface .....*P. argyracea*

11. Isidia absent or when present, not coraloid; pseudocyphellae confined mostly to the lower surface .....12

12. Marginal phyllidia or  $\pm$  flattened, dissected isidia present; thallus fragile, thin and papery,  $\pm$  broadly lobed, glabrous on the upper surface, with raised margins; usually on rocks, logs or tree buttresses, common .....*P. dissimilis*

12. Phyllidia or isidia absent or sparse; lobes elongate, narrow and richly divided, sometimes minutely tomentose and maculate near the tips, frequently bearing green leaflets of *Pseudocyphellaria multifida*; usually in deep shade on logs or epiphytic, uncommon .....*P. brattii*

13. Upper surface pale yellow-green when wet or dry; lower surface dark brown; lobes  $\pm$  rounded at the tips.....14

13. Upper surfacee grey-green when dry, dark green or bright lettuce green when wet (rarely suffused brownish or blaekish); lower surface cream to dark brown; lobes elongate, linear, with  $\pm$  truncate tips.....15

14. Lobes with marginal, easily abraded isidia; very common polymorphic species on trees, rocks and logs .....*P. glabra*

14. Lobes with coarse marginal soredia; rather uncommon, on rocks....*P. soredioglabra*

15. Thallus coarsely granular sorediate; soralia marginal and laminal,  $\pm$  concolorous with the upper surface of the thallus ..... *P. granulata*

15. Thallus not sorediate ..... 16

16. Upper surface of thallus smooth to undulate; lobes much divided, with folioles or small, lateral lobes along the margin; branching  $\pm$  random; undersurface cream to light brown; apothecial disc red-brown ..... *P. multifida*

16. Upper surface markedly faveolate; marginal folioles absent; branching  $\pm$  dichotomous; apothecial disc dark brown or black ..... 17

17. Individual faveolae usually as broad as the lobes; marginal pseudocyphellae absent; apothecia mainly marginal; undersurface dark brown or sometimes fawn, particularly at the tips of the lobes; tomentum frequently patchy; lacking physciosporin ..... *P. billardierei*

17. Usually several faveolae spanning the width of the lobes; marginal pseudocyphellae present; apothecia marginal and laminal (on the ridges of the faveolae); tomentum on the undersurface very dense, dark brown, protruding somewhat beyond the lobe margins and visible from above as a slight fringe; containing physciosporin (grey-black spot on charred t.l.c. plates) ..... *P. faveolata*

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## New Species in Asteraceae from the Subalps of Southeastern Australia.

N.G. Walsh

National Herbarium of Victoria, Birdwood Ave, South Yarra, Victoria 3141.

### Abstract

*Olearia stenophylla* and *Euchiton poliochlorus* are described and illustrated. Their distributions, habitats, conservation status and relationships to closely related congeners are discussed. Both species are apparently endemic to subalpine areas of south-eastern Australia.

### Introduction

In the course of curating Asteraceae at MEL and compiling accounts for the fourth volume of the *Flora of Victoria*, a number of undescribed taxa were encountered. One of these has long been recognized as an unnamed taxon in Australia, others appear to have been overlooked in herbaria and the field. The opportunity is here taken to provide names for two of these species, both endemic to subalpine areas of south-eastern Australia. Other taxa will be dealt with in subsequent papers.

### Taxonomy

#### *Olearia stenophylla* N.G. Walsh, sp. nov.

*Olearia asterotrichae* (F. Muell.) F. Muell. ex Benth. affinis foliis longioribus linearis acutis, supra glabris nitentibus, bracteis involucralibus inaequalibus, et indumento tenuissimo differt.

*Type*: New South Wales, Kosciuszko National Park, Tumut Ponds Fire Trail, G. Wright 102, 10.xii.1998 (holotype MEL 2054189: isotypes CANB, NSW).

*Shrub* to c. 1.2 m high, usually multistemmed from base and more or less leafless in the lower half. Younger stems, undersurfaces of leaves and peduncles densely floccose with white to pale fawn stellate hairs. *Leaves* alternate, sessile, oblong to linear, 40–80 mm long, 1–5 mm wide, apex acute, base cuneate, margins entire, recurved to revolute, adaxial surface glabrous at maturity, but with small, scattered tubercles, lustrous, with impressed reticulate venation, very young leaves with sparse stellate hairs. *Capitula* in corymbs terminating main branches and short lateral branchlets. *Peduncles* mostly 1–3 cm long. *Involucre* broadly obconic. *Bracts* 3–4-seriate, the outermost ovate, c. 1 mm long, the innermost oblong to narrow-ovate, 3.5–4.2 mm long; stereome green, margin chartaceous, mostly entire, fimbriolate at or near apex; abaxial surface with sparse multicellular gland-tipped hairs and/or sessile glands, usually with a few eglandular stellate hairs. *Ray florets* 9–14, unisexual, white (rarely pale mauve or lilac), glabrous or with few minute glandular hairs shortly below the ligule. *Ligule* 4–6 mm long, obtuse, entire or minutely 3-lobed apically. *Style arms* filiform, c. 1.5 mm long. *Disc florets* similar in number to ray florets, corolla c. 4 mm long, yellow, sparsely glandular-pubescent on the tube and apices of lobes. *Anthers* linear, c. 1.5 mm long (including the acute apical appendage), shortly exserted from corolla. *Style arms* narrowly obovate, c. 1.2 mm long. *Cypselas* flattened-cylindric to narrow-ovoid, c. 2 mm long, shortly sericeous, obscurely 6-ribbed. *Pappus* biserrate, the outer series of c. 10–20 barbellate bristles or narrow, flattened scales 0.5–1 mm long, the inner series of c. 30–40 barbellate bristles 3–4 mm long. (Fig. 1)



**Fig. 1.** *Olearia stenophylla*; **a** flowering branch  $\times 1$ ; **b** transverse section of leaf  $\times 15$ ; **c** capitulum  $\times 3$ ; **d** cypsela (upper part of pappus not illustrated)  $\times 30$  (all from Wright 102, MEL).

**Specimens Examined:** NEW SOUTH WALES (all Kosciuszko National Park): Happy Jacks River Gorge, 28.xi.1954, *M. Mueller* s.n. (MEL); Tumut Pond, Clear Creek Valley, 16.xii.1954, *M. Mueller* s.n. (MEL); Happy Jacks Gauging Station, 5.i.1960, *M.E. Phillips* s.n. & *J.E. Raeder-Roitzsh* (CANB); Cabramurra-Khancoban Rd, 2 km south of dam wall at Tumut #1 Reservoir, 10.xii.1998, *N.G. Walsh* 4892 (MEL, CANB); Tumut Ponds Fire Trail, 10.xii.1998, *G. Wright* 103 (CANB, MEL).

**Distribution and Conservation Status:** Apparently confined to an area of c. 9 km × 5 km in the catchment of the Tumut River (including Clear Ck, Happy Jacks Ck) above its impoundment by the Tumut Pond Dam, in the Kosciuszko National Park, New South Wales (Southern Tablelands). It is locally common within this area, but using the criteria of Briggs and Leigh (1996) its conservation status would be assessed as 'rare'. Further searches within the general area, particularly in the lower catchments of Nine Mile Ck and Temperance Ck are likely to increase the number of known populations (but perhaps not the overall range) of the species.

**Habitat:** All known populations occur within *Eucalyptus pauciflora* woodland (occasionally with other eucalypts such as *E. stellulata*, *E. perriniana*) between 1200 and 1400 m altitude. The substrate is typically shallow soil derived from shaly sedimentary substrate. Typically associated shrub species include *Olearia phlogopappa*, *Podolobium alpestre*, *Ozothamnus secundiflorus*, *Grevillea victoriae* s.l.

**Phenology:** Flowering specimens have been collected from late November to mid December.

**Notes:** According to herbarium collections at MEL and CANB, only three specimens of *O. stenophylla* had been collected prior to 1998, two of these in 1954, one in 1960. Since 1954, areas adjacent to the collecting localities had been flooded as part of the Snowy Mountains Hydroelectric Scheme, and there were concerns that the species may have been extinguished or severely depleted before being taxonomically recognised. Fieldwork in late 1998 confirmed the continued existence at the known sites, and extended its range slightly. The few specimens of *O. stenophylla* collected prior to 1998 had been referred to *O. asterotricha* (F. Muell.) F. Muell. ex Benth. from which it differs in the generally longer, linear leaves that are glabrous and shining on the adaxial surface, the shorter involucre with bracts that increase in size from the outermost to the innermost series (those of *O. asterotricha* being 4–7 mm long and of almost uniform length), and the finer indumentum (the stellate hairs of *O. stenophylla* being typically c. 0.2 mm diam. and those *O. asterotricha* being typically 0.5 mm diam. or more). The leaves of *O. stenophylla* superficially resemble those of *O. rosmarinifolia* which occurs in the general vicinity, but that species has predominantly opposite leaves with raised reticulate venation on the adaxial surface and a dense indumentum of appressed medifixed hairs on the lower surface, and glabrous or subglabrous achenes with a uniseriate pappus. *O. phlogopappa* is common throughout the general area in which *O. stenophylla* occurs, and is clearly related to it, but is readily distinguished by its broader leaves that are dull (and sometimes scurfy-pubescent) on the adaxial surface, with flat, typically lobed or toothed margins, finer indumentum and uniseriate pappus.

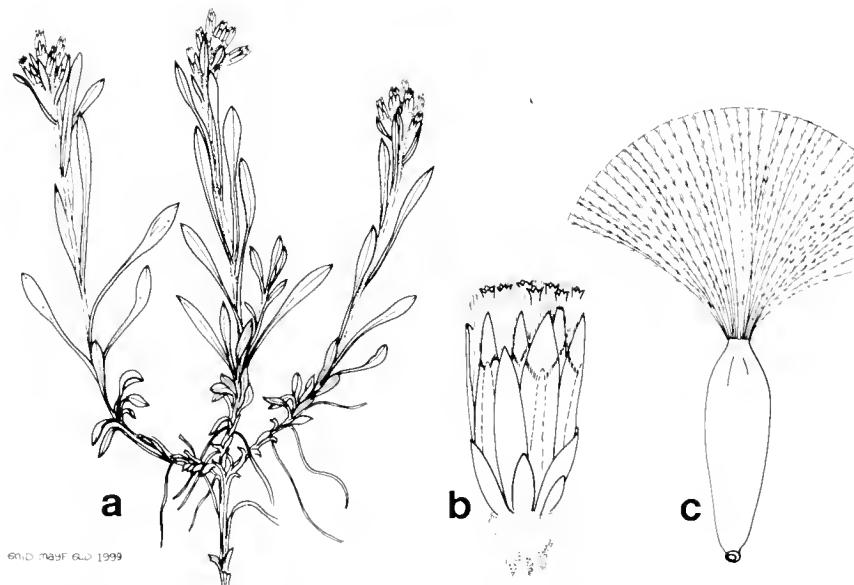
The species is not recorded by Lander (1992).

**Etymology:** The epithet is derived from the Greek (*stenos* = narrow, *phyllon* = leaf) and refers to the characteristic linear to oblong leaves.

#### *Euchiton poliochlorus* N.G. Walsh, sp. nov.

*E. fordiano* M. Gray et *E. argentifolius* N.A. Wakef. affinis, a primo foliis angustioribus, capitulis paucioribus, a secundo capitulis largioribus, et ab ambobus foliis griseo-viridis (non albidis) differt.

**Type:** Victoria, Baw Baw Plateau, headwaters of West Tanjil River, 18.i.1982, *N.G. Walsh* 658 (holotype: MEL 605140; isotypes (2) CANB).



**Fig. 2.** *Enchiton poliochrous*; **a** habit  $\times 1.2$  (Adair 996, MEL); **b** capitulum  $\times 6$  (Walsh 658, MEL); **c** cypsela (upper part of pappus not illustrated)  $\times 30$  (Walsh 3055, MEL).

Rhizomatous perennial *herb*, sometimes loosely mat-forming. Leaves mostly crowded near base of plant. Lower leaves narrow-oblanceolate or -spatulate, commonly with petiole-like base subequal to broader 'blade', 1.5–3.5(–5) cm long overall, 1.5–4(–6) mm wide, terminating in a minute, thickened glabrous point, surfaces equally grey-green with moderately dense, appressed cottony hairs, slightly 'looser' abaxially; midrib not or scarcely raised on adaxial surface, but prominent abaxially, lateral venation not apparent. Flowering stems unbranched, erect, 4–12 cm high (to 20 cm in fruit), densely white-cottony, with 6–12 leaves, reducing toward inflorescence. Inflorescence of 3–5(–7) capitula, racemously arranged, initially compact and head-like, the main axis and peduncles elongating in fruit to c. 25 mm and 12 mm respectively, each capitulum subtended by a reduced leaf-like bract. Capitula cylindric; involucral bracts translucent, brownish-green near base, usually with a reddish band near the middle, stramineous toward the apex. Outermost bracts ovate, 2–3 mm long, sparsely cottony near base; inner bracts more or less oblong, 5–6.5 mm long, glabrous, obtuse or ruminate at apex. Bisexual florets 3–7. Female florets c. 20–35. Corollas 4–4.5 mm long. Cypselas narrowly obovate, 1.4–1.6 mm long, 0.4–0.6 mm wide, flattened, smooth and glabrous. Pappus of c. 30–50 slender barbellate bristles 4–5 mm long, united at base for c. 0.1 mm, readily detaching from cypselas. (Fig. 2)

*Representative specimens:* NEW SOUTH WALES (all Kosciuszko National Park); Snowy River, below Spencers Creek, alt. 1630 m, 26.i.1973, J. Thompson 1749, 1751 (NSW); Guthega River, alt. 1585 m (5200 ft), 30.i.1974, J. Thompson 2004 (NSW); Above Charlottes Pass toward Mt Kosciuszko summit, 23.ii.1978, M. Gray 6854 (CANB); Southern end of Perisher Range, 10.ii.1966, M. Gray 5910A (CANB); Between Soil Conservation Hut and the Chalet, 23.ii.1970, E. Dahl s.n. (CANB); McKeahnies Ck catchment, Happy Jacks Plain, 28.i.1965, M.E. Phillips s.n. (CANB). VICTORIA: Bogong High Plains, Watchbed Ck, 26.i.1966, A.C. Beaglehole 15617

(MEL); Snowy Range, Bryce Plain, 31.xii.1972, A.C. Beauglehole 40852 & E.A. Chesterfield (MEL); c. 0.8 km (0.5 miles) NW of Mt Nunniong, 22.i.1971, A.C. Beauglehole 36445 & E.W. Finck; Mt Buffalo Plateau, between The Horn & Wilfreds Hill, 18.ii.1963, J.H. Willis s.n. (MEL). Tasmania: Cradle Mountain Reserve at 3,500 ft (1100 m), W.M. Curtis s.n. (HO).

**Distribution and Conservation Status:** Moderately common in subalpine and alpine areas of the Southern Tablelands of NSW, from Kiandra area south to the summit area of Mt Kosciuszko. In Victoria scattered through the Snowfields region (Conn, 1992) where suitable habitat occurs (e.g. Nunniong Plateau, Mt Buffalo, Bogong High Plains, Snowy Range, Baw Baw Plateau). Recorded only from Cradle Mountain area in Tasmania. Not considered rare, and well represented in conservation reserves. Apparently not present in New Zealand, which shares with Australia other closely related species of *Euchiton* (Drury 1972, Curtis 1963).

**Habitat:** Usually occurring in *Sphagnum* mossbeds, wet heathland or wetish grassland communities at altitudes between c. 1400 and 1850 m on the mainland, but at c. 1100 m in Tasmania..

**Phenology:** Flowering specimens have been collected from December to February.

**Notes:** This species most closely resembles *E. fordianus* and *E. argentifolius* (see footnote below) which, like *E. poliochlorus* are both alpine or subalpine species having more than one capitulum per inflorescence. *E. poliochlorus* can be distinguished from *E. fordianus* by the fewer, narrower capitula, and from *E. argentifolius* by the larger capitula, and from both by the grey-green rather than silvery-white leaves. Both *E. fordianus* and *E. argentifolius* tend to be species of drier grassland or open heathland communities than does *E. poliochlorus*.

Although *Euchiton* is generally regarded as being characterised *inter alia* as having paired papillae and often clavate hairs on the epidermal cells of the cypselae (e.g. Drury 1970, Anderberg 1991, Bremer 1994), even at  $\times 80$  magnification the cypselae epidermis of *E. poliochlorus* is reasonably described as smooth and glabrous. Electron microscopy reveals that the epidermal cells each have a minute distal papilla but appear to lack proximal papillae (A. Rozefelds pers. comm.). True hairs are lacking. The correlation between cypselae morphology and segregate genera formerly included in *Gnaphalium* is currently being investigated by A. Rozefelds (Tasmanian Herbarium, Hobart).

**Etymology:** The epithet is derived from Greek (*polios* = grey, *chloros* = green) and refers to the colour of the leaves. It is chosen to be contrasted with the silvery or silvery-white leaves of closely related, largely sympatric species.

The following key is provided to allow the mainland Australian, subalpine to alpine, grey- or silver-leaved terrestrial species of *Euchiton* to be distinguished.

1. Inflorescence of several capitula.....2
1. Inflorescence of a single capitulum.....4
2. Inner involucral bracts 3.8–5 mm long; leaves silvery-white.....*E. argentifolius*
2. Involucral bracts usually 5 mm long or more (if ever only 5 mm, then leaves grey-green).....3
3. Leaves silvery-white, 5 mm wide or more; inflorescence of 5–15 capitula.....*E. fordianus*
3. Leaves grey-green, rarely wider than 4 mm; inflorescence of 3–5(–7) capitula.....*E. poliochlorus*
4. Leaves more or less oblong, less than 1 cm long; capitula sessile in flower (sometimes shortly pedunculate in fruit); inner involucral bracts 7–9 mm long.....*E. nitidulus*
4. Leaves oblanceolate to spatulate, the longest more than 1 cm long; capitula normally pedunculate in flower; inner involucral bracts under 7 mm long.....5

5. Leaves to 15 mm long, crowded at base but not rosetted; flowering stems with about 5–10 leaves not or barely smaller than basal leaves; inner involucral bracts 3.8–5 mm long; cypselas usually glabrous; plants usually mat-forming.....*E. argenteifolius*
5. Leaves 15–30(–50) mm long, rosetted; flowering stems with c. 1–5 much-reduced leaves; inner involucral bracts 5–6.5 mm long; cypselas shortly and sparsely hairy; plants rarely mat-forming .....*E. traversii*

### Acknowledgments

I am grateful to Keith McDougall and Gen Wright of the New South Wales National Parks and Wildlife Service for checking *Olearia* collections in CANB and Kosciuszko National Parks Herbarium, and for assistance with fieldwork, to Jo Palmer and Joy Everett (CANB and NSW respectively) for checking their holdings of *Euchiton*, to Max Gray (CANB), Andrew Rozefelds (HO) and an anonymous referee for their helpful comments re *E. poliochlorus*, and to curatorial staff at CANB, CHR and NSW for prompt provision of loan material. I thank Enid Mayfield (MEL) for illustrating the species described in this paper.

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### Footnote

Subsequent to the preparation of this paper it has been brought to my notice that due to Wakefield's inadvertent incorrect assignation of the type specimen for *G. argenteifolium*, the name *Euchiton argenteifolius* as used in the present paper probably refers to two entities, and that in the strict sense *E. argenteifolius* may be confined to Tasmania. In the diagnosis for and notes following the description of *E. poliochlorus*, and in the key to related species, the name *E. argenteifolius* is used for that taxon currently regarded as such in mainland Australia, although the comparisons made are probably equally relevant to Tasmanian material referred to that name.

## New Subspecies of *Leionema lamprophyllum* (F. Muell.) Paul G. Wilson (Rutaceae).

F.M. Anderson

National Herbarium of Victoria, Birdwood Avenue, South Yarra, Victoria 3141, Australia.

### Abstract

A morphological study of *Leionema lamprophyllum* (F.Muell.) Paul G.Wilson has identified three entities here recognised as subspecies: *Leionema lamprophyllum* subsp. *lamprophyllum*, which is endemic to subalpine regions of Victoria; *L. lamprophyllum* subsp. *orbiculare* F.M. Anderson subsp. nov.; which is endemic to New South Wales; and *L. lamprophyllum* subsp. *obovatum* F.M. Anderson subsp. nov.; which is found in the Australian Capital Territory, New South Wales and Victoria. Their distributions, habitats, and conservation status are discussed. A key to the subspecies of *L. lamprophyllum* is provided.

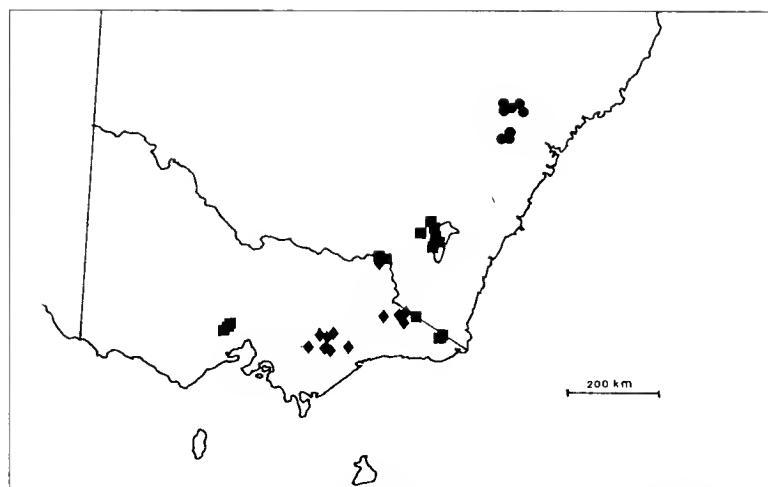
### Introduction

Wilson (1970) noted morphological variation in *Phebalium lamprophyllum* (F.Muell.) Benth. 'as a topocline' from Rylstone, New South Wales, in the north to Victoria in the south. This species was transferred to the new genus *Leionema* by Wilson (1998). Field observation and inspection of herbarium specimens held at CANB, MEL, NE, and NSW indicate that *L. lamprophyllum* is a polymorphic species containing three distinct entities of distinct morphology and distribution. These entities are here formally described as subspecies.

### Taxonomy

*Leionema lamprophyllum* (F. Muell.) Paul G. Wilson. *Nutisia* 12(2): 267–288. *Eriostemon lamprophyllus* F. Muell., *Quart. J. Pharm. Soc. Victoria* 2: 43 (1859). Type: mountains on the Macalister River, Victoria, January 1859, F. Mueller (lectotype, here designated MEL 4784; isolectotypes AD n.v., K n.v., MEL 4318, MEL 4785, NSW n.v.). *Phebalium lamprophyllum* (F. Muell.) Benth., *Fl. Austral.* 1: 340 (1863).

Compact shrub to 2 m high. *Branchlets* terete or angular when immature, sparsely to densely glandular-verrucose, pilosulous to pilose with simple and 2–8-rayed stellate hairs in longitudinal lines between glabrous leaf-decurrencies or, in subspecies *orbiculare*, with stellate hairs all round the branchlets. *Leaves* alternate. *Petiole* 0.3–1.2 mm long, glabrous or sometimes pilosulous with stellate hairs. *Lamina* subcoriaceous, elliptic to broadly obovate to orbicular, (1.7–)2.4–10.6(–14.2) mm long, (1.3–)2.2–4.3(–5.4) mm wide, usually glabrous but sometimes pilosulous with simple or stellate hairs along the margin and/or midrib; leaf base attenuate to obtuse, margin often flushed pink, plane to slightly recurved when dry, entire to minutely erose or crenate at apex, apex acute to obtuse or, in subspecies *orbiculare*, minutely mucronate, apex sometimes crowned with a cluster of simple hairs; adaxial surface glossy, appearing smooth to the naked eye but covered in minute tubercles, prominently glandular-punctate, glands generally become sunken when dry and lamina wrinkled due to contraction of mesophyll tissue between glands, midrib flat or slightly impressed lateral nerves not visible; abaxial surface paler than adaxial surface. *Inflorescences* terminal or in upper axils of umbellate cymes, rarely flowers terminal and solitary. *Pedicel* slender to somewhat expanded and fleshy at apex, 1.0–6.0 mm long, with a sparse minute stellate indumentum. *Prophylls* elliptic, 0.3–2.5 mm long, one subtending each pedicel, leaf-like, concavo-convex, glabrous or with a few



**Fig. 1.** Distribution of *Leionema lamprophyllum*: ▲ = subsp. *lamprophyllum*; ■ = subsp. *obovatum*; ● = subsp. *orbicularis*.

simple to minutely stellate hairs. *Metaxyphylls* minute, 0.2–0.6 mm long, 2 occurring in lower half of pedicel, concavo-convex with a few minute simple hairs on outer surface, margin ciliate. *Flower bud*, obovoid, white to pink. *Sepals* deltoid, concavo-convex, 0.3–0.6 mm long, fleshy, glandular-punctate, margin ciliate. *Petals* narrow-elliptic, 2.0–4.4 mm long, white with tips often flushed pink on abaxial surface, caducous, glandular-punctate on abaxial surface, glabrous, apex inflexed, midrib prominent. *Stamens* equal to or slightly exceeding petals, filaments slender, terete to slightly flattened, tapering distally, 2.2–5.2 mm long, glabrous, anthers cordate-ovate, 0.4–0.9 mm long, dorsifixed and versatile, pale pink or yellow. *Gynophore* short-cylindrical, 0.2–0.7 mm high, red, glabrous, slightly narrower than the ovary. *Ovary* sub-spherical to ± cylindrical, 0.5–2.0 mm high, glabrous, upper 1/3 to 1/2 sterile. *Style* terete, 1.5–3.7 mm long, glabrous, gynobasic, equal to stamens, stigma only slightly differentiated. *Fruit* a schizocarp. *Cocci* usually 2–4, spreading, 2.1–4.0 mm long, obliquely ovoid, sparsely glandular-punctate, outer edge minutely apiculate to shortly rostrate, apiculus/beak 0.4–1.7 mm long. *Seed* narrowly ovoid, 2.2–3.5 mm long, raphe basal, testa smooth and thinly crustaceous, glossy black to dark brown, aril cream-coloured; surface at magnification smooth, epidermal cells with junction of anticlinal walls sunken.

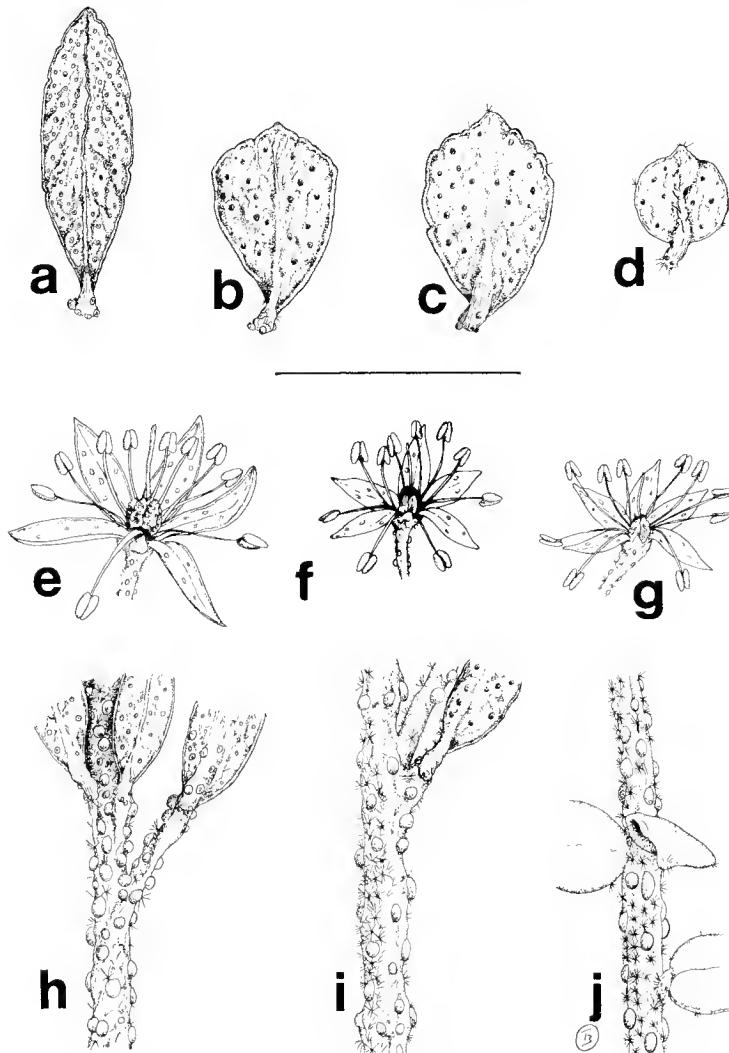
*Distribution:* *Leionema lamprophyllum* occurs along the Great Dividing Range of south eastern Australia, from Rylstone c. 140 km north-west of Sydney, southwards to the Brisbane Ranges c. 70 km west of Melbourne (Fig. 1).

#### Key to the subspecies of *Leionema lamprophyllum*

1. Leaves suborbicular to orbicular, (1.7–)2.4–3.2(–3.9) mm long, apex rounded to minutely mucronate ..... subsp. *orbiculare*
1. Leaves elliptic to obovate, (2.6–)4.0–10.6(–14.2) mm long, apex acute to obtus ..... 2
2. Leaves elliptic, (5.6–)7.6–10.6(–14.2) mm long; apex acute, margin entire to minutely erose toward apex; petals (3.3–)3.7–4.3(–4.4) mm long; pedicel (3.0–)3.5–5.0(–6.0) mm long ..... subsp. *lamprophyllum*
2. Leaves obovate to broadly obovate, (2.6–)4.0–6.2(–9.0) mm long; apex obtuse (rarely subacute), margin entire to minutely erose or crenulate toward apex; petals (2.0–)2.4–3.7(–4.3) mm long; pedicel (1.0–)1.5–2.7(–3.8) mm long ..... subsp. *obovatum*

*Leionema lamprophyllum* (F. Muell.) Paul G. Wilson subsp. *lamprophyllum* Type indicated above under *Leionema lamprophyllum*.

Branchlets prominently glandular-verrucose, pilosulous to pilose with simple or 2—8-rayed stellate hairs in longitudinal lines between glabrous leaf-decurrencies. *Petiole* mostly 0.5—1.2 mm long. *Lamina* elliptic, (5.6—)7.6—10.6(—14.2) mm long, apex acute and usually glabrous but sometimes pilosulous, margin entire to minutely erose toward apex, leaf base attenuate. *Peduncle* (2.8—)3.3—5.3(—6.0) mm long. *Pedicel* (3.0—)3.5—5.0(—6.0) mm long. *Prophylls* mostly 0.5—2.5 mm long. *Metaxyphylls* 0.2—0.4 mm long. *Sepals* mostly 0.3—0.6 mm long. *Petals* (3.3—)3.7—4.2(—4.4) mm long. *Stamens* (3.2—)3.7—4.3(—4.7) mm long; anthers mostly 0.6—0.9 mm long. *Gynophore* mostly 0.4—0.7 mm long. *Ovary* (1.1—)1.2—1.8(—2.0) mm long. *Style* gynobasic, (1.9—)2.0—2.4(—2.7)



**Fig. 2.** *Leionema lamprophyllum*; **a-d** leaves  $\times 5$ ; **a** subsp. *lamprophyllum*; **b, c** subsp. *obovatum*, **d** subsp. *orbicularis*; **e-g** flowers  $\times 5$ ; **e** subsp. *lamprophyllum*, **f** subsp. *obovatum*, **g** subsp. *orbicularis*; **h-j** stem detail  $\times 5$ ; **h** subsp. *lamprophyllum*, **i** subsp. *obovatum*, **j** subsp. *orbicularis* (**a, d, h** from Willis s.n. MEL; **b, f, i** from L.D. Pryor s.n., NE; **c** from N.A. Wakefield 318, MEL; **g, j** from P.M. Althofer, NE).

mm long. *Cocci* minutely apiculate to shortly rostrate, mostly 3–4 mm long; beak/apiculus mostly 0.6–1.7 mm long. *Seed* mostly 2.5–3.6 mm long. (Fig. 2a, e, h)

*Representative Specimens* (27 specimens examined): VICTORIA: Little River Gorge Lookout, 5.i.1970, A.C. Beaglehole 33156 & E.W. Fiuck (MEL); Ballantyne Hills, 17.i.1970, A.C. Beaglehole 33386, K.C. Rogers & E.W. Fiuck (NSW); Reedy River Gorge, Nunniong Plateau, 13.xi.1964, J.H. Willis (MEL); Macalister River, F. Mueller s.n. (MEL); Wellington River, c 8 km due N of Licola, 30.xii.1998, F.M. Anderson 7–10 & N.G. Walsh (MEL); Mount Ray c. 45 km NNE of Sale, 30.xii.98 F.M. Anderson 3–6 & N.G. Walsh (MEL); near summit of Mount Hedrick, Spring 1992, J. Hoey s.n. (MEL).

*Distribution and Conservation Status:* *Leionema lamprophyllum* subsp. *lamprophyllum* is apparently endemic to Victoria, occurring in the Eastern Highlands and East Gippsland natural regions of Conn (1993) on and south of the Great Dividing Ranges, from near Erica eastwards to Mt Tingaringy on the New South Wales border, with concentrations in the Lieola and Suggan Buggan areas (Fig. 1). This subspecies may possibly occur in Koseuszko National Park which is close to known populations at Mount Tingaringy. Further searches of likely habitat are required to confirm this possibility. The Risk Code (*sensu* Briggs and Leigh 1995) for *L. lamprophyllum* subsp. *lamprophyllum* is assessed at 3RC- P3 with populations reserved in Baw Baw National Park, Avon Wilderness Park, and the Alpine National Park.

*Habitat:* Subspecies *lamprophyllum* is recorded to occur on rocky and exposed escarpments, often with a NE to NW aspect, and skeletal soils derived from sedimentary rocks (e.g. mudstone, sandstone) or in shallow gravelly soils derived from conglomerate and rhyodacite parent material. It is usually a component of subalpine (shrubland or *Encalypta*-dominated woodland) communities. Flowering: Winter-Spring; fruiting: Spring-Summer.

*Notes:* A population at Mt Ray (c. 45 km NNE of Sale) contains plants with leaves at the lower limit of the length:width ratio, some of which, on this attribute alone might key to subsp. *obovatum*. Field examination of the population showed that these extremes were from plants growing in heavily shaded sites. All other specimens collected at this site agree with the typical form.

***Leionema lamprophyllum* subsp. *orbiculare* F.M. Anderson subsp. nov.**

A subspecies typica foliis minoribus orbicularibus, basi obtusa, apice mucronata minute differt.

*Type:* New South Wales, Currant Mountain Gap, ea. 24 km east of Rylstone, 10.viii.1975, R. Coveny 6609 & P. Hind. (holotype NSW 469920; isotypes A n.v., CANB 249985, K n.v., L n.v., LE n.v., MO n.v., P n.v., PERTH n.v., PRE n.v., RSA n.v.)

Branchlets sparsely glandular-verrucose with 2–8- rayed stellate hairs all around the branchlets. *Petiole* mostly 0.3–1.0 mm long. *Lamina* suborbicular to orbicular, (1.7)–2.4–3.2(–3.9) mm long, apex rounded to minutely mucronate and often pilosulous, otherwise glabrous, margin entire, plane to recurved when dry, leaf base obtuse. *Peduncle* (1.0)–1.7–3.3(–4.5) mm long. *Pedicel* (1.1)–1.7–3.2(–4.9) mm long. *Prophylls* (0.3)–1.2–1.8(–2.3) mm long. *Metaxyphylls* minute, mostly 0.3–0.5 mm long. *Petals* (2.3)–2.8–3.2(–3.7) mm long. *Stamens* (2.5)–3.2–3.8(–4.4) mm long; anthers mostly 0.5–0.8 mm long. *Gynophore* mostly 0.3–0.5 mm long. *Ovary* (0.6)–0.8–1.0(–1.3) mm long. *Style* (2.1)–2.6–3.5(–3.6) mm long. *Cocci* minutely apiculate, mostly 2.1–3.1 mm long; apiculus 0.4–0.6 mm long. (Fig. 2d, g, j)

*Representative Specimens* (34 specimens examined): NEW SOUTH WALES: Kyber Pass c. 37 km east of Rylstone, 4.x.1969, J.H. Willis s.n. (MEL); Head of Coricudgy Creek, 30.viii.1957, L.A.S. Johnson s.n. (MEL); East side of Lithgow Water Supply, 21.x.1939, M. Blakely s.n. & J & W. Buckingham (NSW); Carne Creek Cliffs, Newnes State Forest, 22.ix.1987, P. Hind 5330 & G. D'Aubert (NSW); Hills east of Rylstone, vi.1950, S. Smith-White & H.S. McKee s.n. (NE); "Kyber" Currant Mountain Gap, ix. 1951, P.M. Althofer s.n. (NSW); Kandos Weir Picnic Area, 29.ix.1979, A.D. Chapman 1469 (CANB, NSW).

*Distribution and Conservation Status:* *Leionema lamprophyllum* subsp. *orbiculare* is known from three localities in the Central Tablelands and Central Western Slopes of New South Wales, occurring along the Great Dividing Range in a linear band from Rylstone to Lithgow (Fig. 1). The region directly east of Rylstone includes Olinda, Kandos Wier, Mount Coricudgy, and Currant Mountain Gap (also known as the "Kyber Pass"). Collections from the Lithgow area come from Morts Gully, Lithgow Water Supply-Clarence and to the north in Newnes State Forest.

Subspecies *orbiculare* has a very restricted distribution with a range of less than 100 km, and employing the criteria of Briggs and Leigh (1995) has a Risk Code Risk Code 2R- P3. This subspecies is known mainly from collections within State Forests (e.g. Newnes, Coricudgy), Wollemi National Park (south side of Dunns Swamp) and around Currant Mountain Gap which is not in a reserve.

*Habitat:* This subspecies is apparently confined to exposed rocky sites often with a NE to NW aspect on sandy loams and skeletal soils derived from Triassic Narrabeen Sandstone. In this heavily dissected sandstone country the parent material is often exposed forming ridges, ledges, turrets or domes. There have also been a few collections taken at sites where the subspecies was growing in cracks through conglomerate defiles.

This subspecies has been recorded by collectors as occurring in a variety of vegetation types from open heath to open shrubland consisting of *Acacia* and *Calytrix* species to low open *Eucalyptus*-dominated woodland. Flowering: Winter-Spring; fruiting: Spring-Summer.

*Notes:* *Leionema lamprophyllum* subsp. *orbiculare* closely resembles *Leionema microphyllum* but differs from that species in having a verrucose stem, short gynophore and glabrous leaves, though occasionally the leaves have simple or minute stellate hairs on the abaxial (rarely the adaxial) surface on the midrib, apex and margin regions.

#### *Leionema lamprophyllum* subsp. *obovatum* F.M. Anderson subsp. nov.

A subspecie typica foliis obovatis, apice rotundato, petalis et pedicellis brevioribus plerumque differt.

*Type:* Australian Capital Territory, Namadgi National Park, Booroomba Rocks, 20.x.1991, A.M. Lyne 447. (holotype MEL 1612094; isotypes CANB 9106172, NSW n.v., PERTH n.v.)

*Branchlets* pilosulous to pilose with simple or 2-8-rayed stellate hairs in longitudinal lines between glabrous leaf-decurrencies. *Petiole* mostly 0.4-1.2 mm long. *Lamina* obovate to broadly obovate, (2.6)-4.0-6.2(-9.0) mm long, apex usually obtuse but sometimes subacute, usually glabrous but sometimes pilosulous, margin usually minutely erose or crenulate toward apex but sometimes entire, leaf base subobtuse to attenuate. *Peduncle* (0.8)-1.3-2.7(-3.6) mm long. *Pedicel* (1.0-1.5-2.7(-3.8) mm long. *Prophylls* mostly 0.8-1.8 mm long. *Metaxyphylls* mostly 0.2-0.6 mm long. *Sepals* mostly 0.3-0.6 mm long. *Petals* (2.0)-2.4-3.7(-4.3) mm long. *Stamens* (2.2)-2.7-3.9(-5.2) mm long; anthers mostly 0.4-0.7 mm long. *Gynophore* mostly 0.2-0.5 mm long. *Style* (1.5)-2.1-3.1(-3.7) mm long. (Fig. 2b, c, f, i)

*Representative Specimens (58 specimens examined):* NEW SOUTH WALES: Brindabella Bridge over Goodradridgee River, 9.ix.1973, T. & J. Whate 3535 (NSW); Kosciusko National Park, c. 15 km SSE of Tumut, 20.xii.1993, N. Taws 301 (CANB, NSW); Micalong Creek, c. 9 km south of Wee Jasper, 1.ix.1986, P. Ollerenshaw 1762 (CANB, NSW). AUSTRALIAN CAPITAL TERRITORY: 0.5 km from Blue Range Road, 10 km from Uriarra Road, 23.vi.1986, M.M. Richardson & P. Ollerenshaw s.n. (MEL); Upper Cotter Dam, x.1958, L.D. Pryor s.n. (CANB, NE); Cotter River, near Black Springs, 5.v.1963, R.G. Adams 622 (MEL); Tidbinbilla Reserve, 17.ix.1969, F. Ingwesen s.n. (CANB). VICTORIA: Brisbane Ranges National Park, 20.vii.1978, E.G. Errey 1447 (MEL); Spectral Track, Brisbane Ranges National Park, 15.xii.98, F.M. Anderson 1 & N.G. Walsh, (MEL); Upper Genoa River, 17.x.1948, J.H. Willis s.n. (MEL); Mid-tops of Mount Burrowa, 17.xi.1971, J.H. Willis s.n. (MEL).

*Distribution and Conservation Status:* *Leionema lamprophyllum* subsp. *obovatum* is known from the Tidbinbilla Range of the Southern Tablelands (due west and south-west

of Canberra) across the Brindabella Range into New South Wales and extending west to the Bogong Mountain Range. In Victoria this subspecies has a disjunct distribution, occurring to the west of Melbourne in the Brisbane Ranges and Werribee Gorge, in the far north east of the state in the Burrowa-Pine Mountain National Park, and in far east Gippsland at Upper Genoa River and Mt Tingaringy (Fig.1).

Although represented in reserves, such as Namadgi National Park and Tidbinbillia Nature Reserve in the Australian Capital Territory, Kościusko National Park in New South Wales and the Brisbane Ranges National Park, Werribee Gorge State Park, Alpine National Park, Burrowa-Pine Mountain National Park and Coopracambra National Park in Victoria, this subspecies still is regarded as rare with a Risk Code of 3RC- P3 (Briggs & Leigh 1995).

**Habitat:** Populations of this subspecies in New South Wales apparently, as reported by collectors, grow on exposed sites usually with a NW to NE aspect in skeletal gravelly soils derived from granitic parent material. In the Namadgi National Park (A.C.T.) the subspecies is reported to grow in sparse to dense shrubland dominated by *Leptospermum* and *Callistemon* species. There are a few records of occurrence on exposed sandstone sites in the Upper Genoa River area in East Gippsland. The Brisbane Ranges populations occur on exposed rocky mudstone escarpments in low open woodland dominated by *Eucalyptus tricarpa*, and/or *Eucalyptus macrorhyncha* woodland with shrubby understory including *Monotoca scoparia* and *Ozothamnus obovatus*. Flowering: Winter-Spring; fruiting: Spring-Summer.

**Notes:** The Brisbane Ranges population of this subspecies is variable in form. The leaf is usually obovate but individuals approach var. *lamprophyllum* in leaf shape and dimensions. Floral characters of these specimens however place them with subspecies *obovatum*.

Two other sites of interest are Mount Tingaringy and Burrowa-Pine National Park where it appears that both subsp. *obovatum* and *lamprophyllum* occur. The specimens from these areas are not in flower, however they agree with respective type forms based on leaf characters. Confirmation of their identity requires further collections of flowering specimens from these sites.

### Acknowledgements

This study was undertaken as the third Jim Willis Student at the National Herbarium of Victoria (MEL). I would like to thank Roger Riordan (Cybec Pty Ltd) for his foresight in instigating this studentship in memory of his friend Jim Willis. I am grateful to the curators at CANB, NE and NSW for the promptly arranged loans of the specimens. I would like to thank all those at MEL who were generous with their time and knowledge, especially Neville Walsh and Marco Duretto who have taught me much about the challenges of taxonomy and who along with Jim Grimes provided sound comment and editorial expertise on this paper. Neville Walsh deserves further thanks for his help in the field and furnishing the Latin description. I am also grateful to Thomas Brosch for the illustration of all three subspecies of *L. lamprophyllum*.

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## ***Podospora petrogale* (Fungi: Sordariales: Lasiosphaeriaceae), A New Species From Australia**

*Ann Bell*

School of Biological Sciences, Victoria University, P.O. Box 600, Wellington, New Zealand. Email: annbell@matai.vuw.ac.nz

### *Abstract*

A new species, *Podospora petrogale* is described from the dung of the Black footed Rock Wallaby (*Petrogale lateralis*) collected in the desert region in the Northern Territory of Australia.

### **Introduction**

It has long been known that the dung of herbivorous mammals provides a rich substrate for a vast assemblage of fascinating and specialised fungi, many of which are restricted to that substrate. The *dung fungi* (as they are generally referred to by devotees), exhibit many beautiful and novel adaptations to their life style. As a consequence of this, some excellent monographs and related publications have appeared over the years. Recently a number of more broad-based publications have appeared enabling these fungi to be more widely used as teaching material in the undergraduate laboratory, (see for example Bell 1983; Richardson & Watling 1997). Nevertheless, there is still much basic systematic research to be done concerning these organisms. There remain vast areas of the world in which little, if any, investigation of the coprophilous mycoflora has been undertaken.

Australia is such a country. With its vast area, diverse ecology and unique marsupial fauna, it doubtless harbours a rich array of coprophilous fungi, a number of which may be endemic. To date only one mycolgist, the notable Major Harry Dade, has done any study of the coprophilous fungal flora of Australia. This he undertook in his retirement years, but unfortunately died before publishing the results of his research. A biographical account of Major Dade's work will appear in a future publication concerning the coprophilous Ascomycetes of Australia.

Little research has been done concerning the coprophilous fungi of desert regions as a whole, although there are a few publications. For example, Angel & Wicklow (1975) describe the succession of coprophilous fungi observed in a semi-arid short grass prairie of Colorado. In another paper the same authors (1983) describe the coprophilous fungal communities in semiarid to mesic grasslands in the western United States. Yocom & Wicklow (1980), describe the coprophilous fungal succession which they observed associated with vegetative succession in dunes. These aforementioned papers deal mainly with the ecology of certain coprophiles and their adaptations to their particularly dry environments.

Regarding fungi from other dry areas, Abdullah *et al.* (1977) record the coprophilous fungi from Iraq; Rattan & El-Buni (1979) describe coprophilous fungi from Libya. Bokhary *et al* (1989) describe some coprophilous fungi identified in Saudi Arabia. There are a number of other publications dealing with country-distribution of these fungi, but little to indicate the collections as being from any particularly dry habitats.

The following is an account of a new species of coprophilous Ascomycete belonging to the genus *Podospora*. It was isolated from the dung of the Black footed Rock Wallaby (*Petrogale lateralis*) collected by Ms Ceri Pearce in a desert area in the Northern Territory. This fungus was noted during the course of a project on the coprophilous Ascomycetes of Australia funded by the Australian Biological Resources Programme (ABRS). Dried dung collected for this project was forwarded to the current author by Dr Tom May at the Herbarium, Melbourne Botanic Gardens, Victoria.

## Materials and Methods

The dung was initially soaked in sterile distilled water before incubating it on to moist filter paper in a lidded glass container (Lundqvist 1972, Bell, 1983). Observations of the fungus were made from water mounts of the fungus in its fresh state, which is by far the most preferable way in which to study these fungi. A number of semipermanent slides were also made using Shear's mounting medium; (Recipe: 300 ml. 2% potassium acetate, 120 ml. glycerine, 180 ml 95% ethyl alcohol. Mix and filter).

A portion of the material was air dried to provide herbarium material. Although all morphological characters were taken into account when describing this species, experience has shown that characters such as ascospore size and shape are much more reliable than the dimensions of elastic structures such as length of ascospores (Bell & Mahoney 1995). A total of 50 ascospores in water mounts were measured from the fresh material.

Cultures were obtained by germinating discharged ascospores which had been immersed in a 3% solution of hydrogen peroxide for 20 min. after which they were streaked across a Petri dish containing 2% water agar. This pretreatment prior to plating had the advantage of killing any unwanted bacteria which may have interfered with the subsequent growth of the fungus. The thick walls of the ascospores may protect them from immersion in the peroxide solution although we have no idea if some of them might be damaged this way, since not all treated ascospores germinate (Bell & Mahoney 1995). Live cultures of this fungus are maintained on Difco Cornmeal agar slopes stored at approximately 0° C at the School of Biological Sciences, Victoria University, P.O. Box 600, Wellington, New Zealand.

## Taxonomy

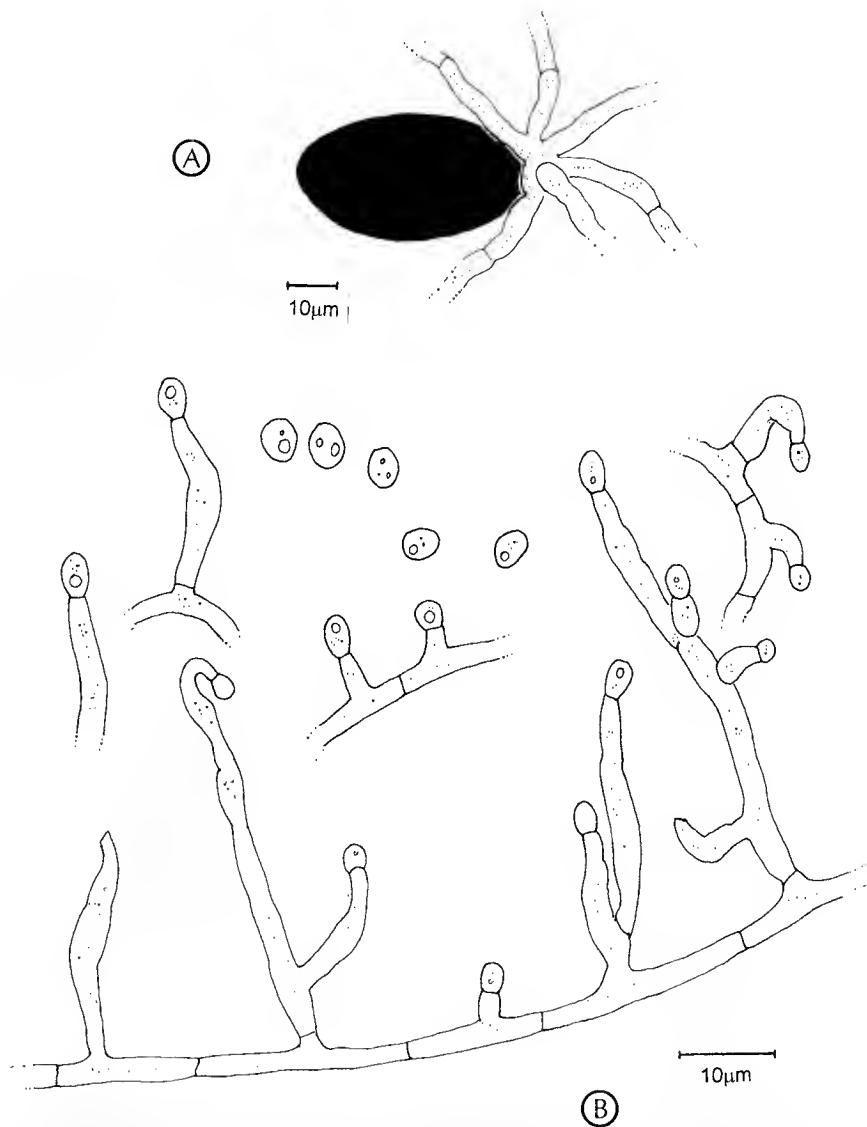
### ***Podospora petrogale* A. Bell, sp. nov.**

Perithecia aggregata, subterranea, sphaeroidea, 1 mm. in diametro, collumi nigro, glabrum, opacum, emersum. Ascii 8-spori, sporae uniseratae maturitate transversc uniseptatae, cella superior (45–)50–58(–60) × (24–)26–30(–32) µm, ellipsoidea vel ovoida, nigrobrunnea, poro germinali apicali, cellula inferior (pedicellus) 12–20 × 4 µm cylindracea, hyalina, recta aut inclinata, distalis lageniformis, evanescens. Tota spora tunica gelatinoso crassus in aqua inflatum, evanescens.

*Type*: Australia, Northern Territory, Simpson Gap, McDonald Ranges near Alice Springs, Lat. 23° 43', Long. 133° 43', substrate (= dung of *Petrogale lateralis*), 12<sup>th</sup> Oct. 1997, C.A. Pearce. (holotype MEL 2062227; isotype WELTU Fungus Collection no. 684).

*Etymology*: Referring to the substrate (dung of *Petrogale lateralis*) upon which the fungus was found.

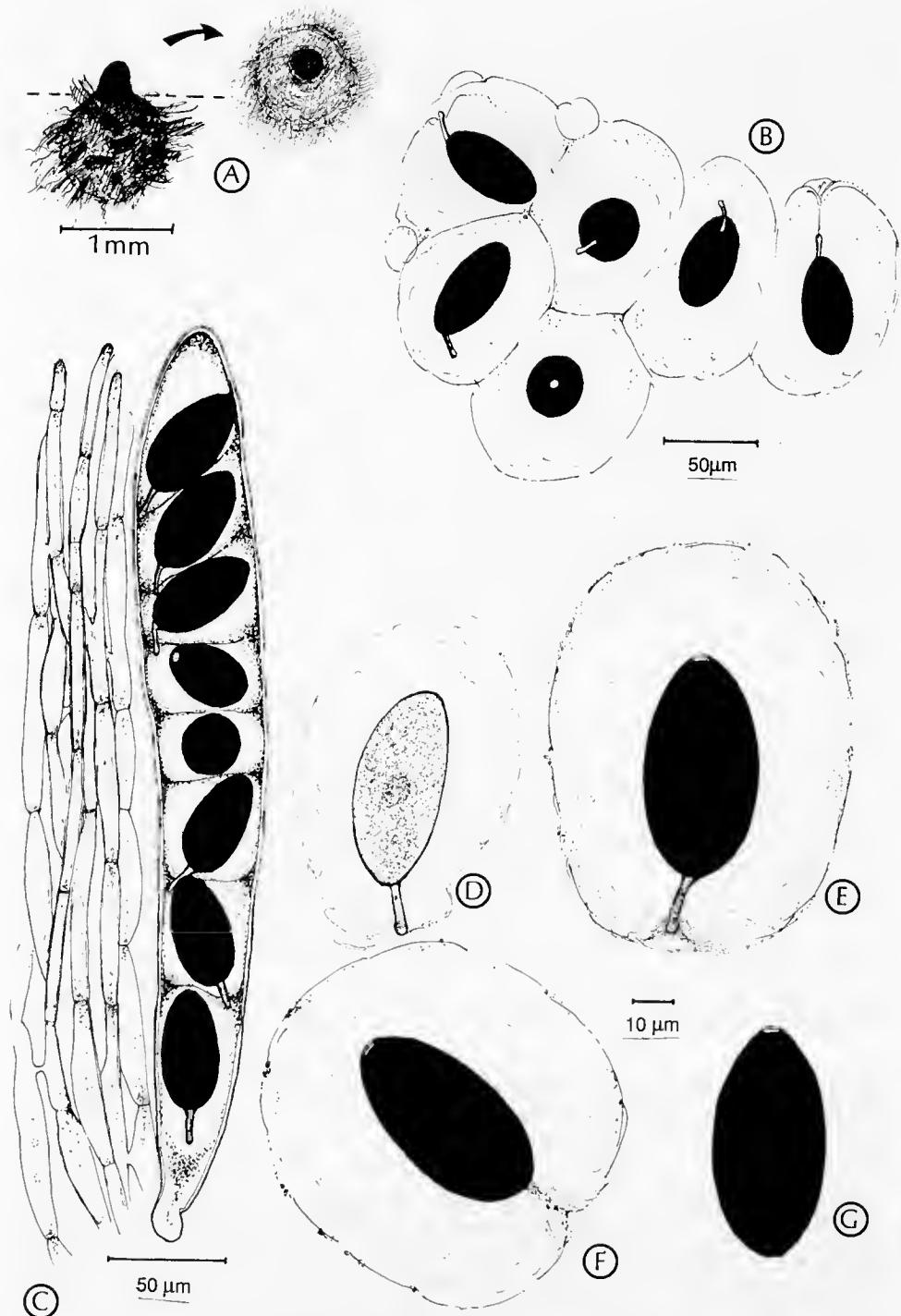
*Characteristics on dung*: Perithecia aggregated but not confluent, submerged beneath the dung surface. Vents more or less spherical, approximately 1 mm in diameter, covered with adhering pieces of ingested vegetation from the dung, very thin walled, readily bursting in water to release their contents. Necks smooth and black, emergent from the dung surface (Fig. 2A). Paraphyses packed around the ascospores, free ended, consisting of single chains of cells with some lateral connections (Fig. 2C). Ascospores cylindric or slightly clavate with a short stalk, approx. 300 × 50 µm, 8-spored. No apical apparatus observed. Ascospores uniseriate, two celled and hyaline at an early stage (Fig. 2D). Upper cell becoming black at maturity, ellipsoidal to slightly ovoid, mostly equilateral but occasionally slightly inequilateral, (45–)50–58(–60) × (24–)26–30(–32) µm, with a prominent apical germ pore 4–6 µm in diameter (Fig. 2C,E,F,G). Hyaline basal cell (=pedicel) straight or slightly inclined to the upper cell, cylindrical often swelling beneath its distal end, 12–20 × 4 µm, evanescent. A broad gelatinous sheath encompasses each ascospore such as to give a cellular appearance to intact ascospores (Fig. 2C). Upon release in



**Fig. 1.** *Podospora petrogale* A Germinating ascospore; B *Phialophora* anamorph of *Podospora petrogale*. For further explanation see text.

water these sheaths swell enormously (up to a diameter of 50  $\mu\text{m}$ ), and discharged ascospores adhere by means of these sheaths (Fig. 2B). In some instances the gelatinous sheaths are extended around the distal ends of the pedicels, or the pedicels may be entirely included within the sheaths (Fig. 2B,D,E). Although the gelatinous sheaths remain visible inside the intact asci in semi-permanent mounting media (at least for the duration of 8 months), gelatinous sheaths and pedicels of released ascospores dissipate over time. Discharged ascospores showing pedicels in various stages of dissolution are illustrated in Fig. 2 E,F.

*Characteristics in culture:* Ascospores produce a number of radiating hyphae from the germination tubes on 2% water agar (Fig. 1A). When transferred to Difco Corn Meal



**Fig. 2.** *Podospora petrogale*. A = Two views of a perithecioid, B = A cluster of discharged ascospores with gelatinous sheaths, C = Ascus and paraphyses, D = Immature ascospore, E = Mature ascospore with gelatinous sheath and pedicel intact, F = Mature ascospore with gelatinous sheath but pedicel partly dissolved, G = Mature ascospore minus sheath and pedicel.

agar, colonies were slow growing reaching a diameter of 0.5 cm in 2 weeks. Colonies hyaline, appressed, producing a *Phialophora* anamorph. Phialides developed singly or in loose groups along the lengths of septate hyphae. Phialides approximately 5–10 × 2–3 µm, sometimes nodding, occasionally branched, without collarettes at their distal ends (Fig. 1B). Phialoconidia 2–3 µm, guttulate, smooth, hyaline, generally broadly obovoid, sometimes with one flattened side, with truncate bases (Fig. 1B). As yet no teleomorph produced in culture.

## Discussion

*Podospora petrogale* is unique insofar as it exhibits features which are both reminiscent of the genus *Strattonia* Cif. (see Lundqvist 1972) and the genus *Podospora* Ces. The encompassing gelatinous sheath surrounding the ascospores is a feature of *Strattonia*, while the evanescent pedicel of *P. petrogale* is very similar in morphology to that found in various species of *Podospora* and quite unlike that described for species attributed to the genus *Strattonia*. Observation of discharged ascospores minus their pedicels could easily lead the observer to misinterpret this fungus for a species of *Sordaria* since there would be no way of knowing at which end of the ascospore the germination pore was situated. However, close scrutiny of such discharged ascospores usually reveals a minute flattened area of the ascospore wall marking the point of attachment of the pedicel.

There are at least 78 named species of the genus *Podospora* in Ainsworth & Bisby's *Dictionary of the Fungi* (1995). A number of monographic and related publications have appeared during recent years, ie. Mirza & Cain (1969), Furuya & Udagawa (1972), Khan & Cain (1972), (Bell 1983), Lundqvist (1970 & 1972), Krug & Khan (1989), Bell & Mahoney (1995 & 1997). However, there are some differences of opinion amongst these authors as to the limitations of the genus, and current knowledge would suggest that the genus may not be monophyletic. For these reasons it would be premature to suggest where *Podospora petrogale* lay regarding its nearest relatives within the genus especially since in aspects of its morphology it straddles both the genera *Podospora* and *Strattonia*.

## Acknowledgements

I wish to extend sincere thanks to Dr Daniel Mahoney and Dr Nils Lundqvist for encouragement and useful discussions.

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## Book Review

**Flora of Australia, volume 48, Ferns, Gymnosperms and Allied Groups.** Editor P.M. McCarthy. Published by CSIRO, Melbourne, 1998; 788 pp.; hardback edition (ISBN 0 643 05971 7) \$AU 94.95; paperback edition (ISBN 0 643 05972 5) \$AU 59.95.

Released in November 1998, this volume marks the 20<sup>th</sup> in the proposed series of the 60-odd volumes of the *Flora of Australia*. At 788 pages, this is significantly the largest volume produced so far in the *Flora* series (vol. 49, Oceanic Islands part 1 was 681 pp.). Introductory essays and descriptions of 586 species are provided by a total of 21 contributors. The text is supported by 213 figures, comprising 176 line drawings and 2 colour paintings, by 17 illustrators, and 36 colour photographs by 7 photographers. A glossary of terms of particular relevance to pteridophytes and gymnosperms is included and augments the general glossary to the series that appeared in Volume 1.

Thirty-nine new taxa and combinations appear in the volume and numerous previously overlooked or resisted names are reinstated. No state will be immune from the need to make some modifications to their current censuses or floras.

This volume will be particularly welcomed by the many enthusiasts of the pteridophytes and gymnosperms as it treats all of Australia's non-flowering vascular plants in a single volume. Australia is not particularly well endowed with conifers, but most of our taxa are important for their considerable evolutionary and biogeographic significance, and our pteridophyte flora is by no means negligible, being in the order of 5% of the world's species.

The pteridophytes and gymnosperms have a particular interest too for their oft-proclaimed role as progenitors of the seed plants. Their ancestral position to the angiosperms is alluded to and their relationships within the major groupings are discussed as fully and plainly as contemporary knowledge permits in a series of excellent introductory essays to the groups. Evidence from the fossil record as well as interpretations from recent morphological, molecular and cladistic analyses are drawn on to support the classifications followed in the volume. However, due recognition is given to the dynamic nature of current phylogenies in the face of volumes of new data being gleaned from modern cladistic and molecular studies.

The 4 gymnosperm divisions (Cycadophyta, Pinophyta, Ginkgophyta and Gnetophyta) are treated at the same rank as the entire angiosperm group (Magnoliophyta). This treatment is based on a body of work which shows the 'gymnospermae' as traditionally understood as a paraphyletic assemblage. Monophyly is supported for each of the gymnosperm divisions and for the angiosperms. While phylogenists will probably be familiar with this grouping, many taxonomists who are less exposed to higher-order systematics will appreciate the overviews offered in this volume. The essays will also provide amusement to future phylogeneticists (who will undoubtedly adopt currently undreamt of schemes), as a snapshot to indicate our quaint, pre-2000 world-view of evolutionary systematics.

The descriptions and keys, as far as I could absorb them, appear to be pleasingly generous in their information content. What appears to be a more compact layout than earlier volumes of the *Flora* has allowed more detailed descriptions, and valuably, numerous notes contrasting often-confused species, discussion of aberrant forms, etc.

The line drawings are generally excellent. I regard them, in total, as the most appealing set produced in the *Flora* series to date. Many of the figures are quite dense, with comparative diagnostic components of commonly 6 or more taxa clearly depicted (e.g. G. Dashorst's almost baroque, but beautiful, work on figs 54 and 159). In my opinion, from both an aesthetic and information-value-for-dollar perspective, this is a significant and welcome departure in style from many of the rather spare figures of earlier volumes. The pictorial coverage is oddly patchy however, with e.g. Zamiaceae (40

Australian species) receiving no line drawings (but a few colour photographs) and only 3 species of Polypodiaceae (28 or 29 Australian spp.) given line drawings (but again, a few photographs). In contrast, we can delight in having a complete, or at least substantial, treatment of most other groups.

I like the placement of figures showing useful examples of frond shapes, degrees of division, sporangial arrangements and frond venation interspersed through the major key to pteridophytes.

I had to search hard to find flaws of any significance in this volume. The few I encountered are given here for the record.

The representation of named hybrids deviates from the traditional form (and recommendation H.3A.1 of the *Code*) in not placing the multiplication sign '×' hard against the epithet (e.g. *Christella × incesta*, p. 347; *Cyathea × marcescens*, p. 199; *Cyclosorus × intermedius*, p. 347; *Drynaria × dumicola*, p. 477).

*Gleichenia rupestris* is not regarded as occurring in Victoria but the species occurs in the far east of the state and was treated in Volume 2 of the *Flora of Victoria*, published in 1994.

The caption to figure 103 refers to *Pellaea falcata* var. *nana*, while this taxon is treated as *P. nana* in the text.

Figures 130, 131 and 132 are attributed to B. Parris. The first 2 bear T. Galloway's insignia, the third is unsigned but appears to have been executed by the same artist as the first two. I could find no other figures attributed to B. Parris in the volume although she is listed as an illustrator.

There is a trivial, but slightly distracting, inconsistency in style of the subheadings on pp. 531 and 532.

Botanists and enthusiasts will welcome the facility of being able to travel with a single volume to allow identification of these distinctive plants throughout Australia. The contributors and editors to this volume are to be warmly congratulated for the production of such a fine piece of work. It is hoped that the standard can be maintained for the run of volumes promised to be released in the near future.

Neville Walsh

## Corrigendum

*Muelleria* 11: 1–4 (1998)

A result of the the 1996 Mueller Commemorative Expedition to northwestern Australia:  
*Melaleuca triumphalis* sp. nov. (Myrtaceae).

L.A. Craven

The plate to the new species (p. 3) was misprinted. A correct copy of the plate is printed below.



## **NOTE FROM THE EDITOR**

The reader will note that the format for *Muelleria* has been changed. This was done in order to save on the number of printed pages. Authors should now follow the format used in this issue of *Muelleria*, or contact the editor for a set of *Instructions to Contributors*.

*The Editor*







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